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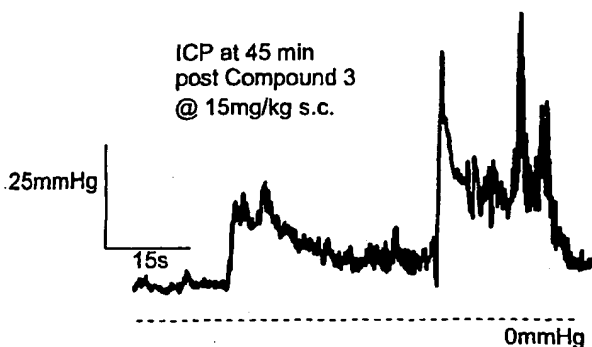
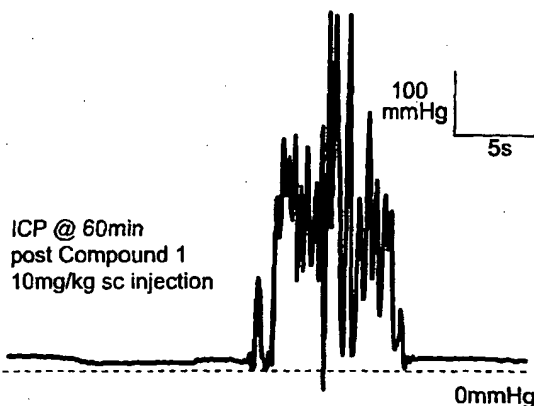
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[Continued on next page]

(54) Title: TREATMENT OF SEXUAL DYSFUNCTION

(57) Abstract: Bombesin receptor antagonists have been found to be useful in the treatment of sexual dysfunction in both males and females. They may be selective BB1 antagonists or mixed BB1/BB2 antagonists. Combinations are disclosed of bombesin receptor antagonists with a range of other active compounds, for example PDE5 inhibitors, NEP inhibitors and lasofoxfene.



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## **TREATMENT OF SEXUAL DYSFUNCTION**

### **FIELD OF THE INVENTION**

The present invention relates to methods for the treatment of sexual dysfunction and to the preparation of medicaments for the treatment of sexual dysfunction.

### **BACKGROUND TO THE INVENTION**

Both males and females can suffer from sexual dysfunction. Sexual dysfunctions are relatively common in the general population (see O'Donohue, 1997). The disorder may relate to seeking sexual behaviour (proceptivity) and/or to acceptance of sexual behaviour, accompanied by sexual arousal (receptivity). The prevalence of sexual problems is higher in populations receiving medicaments, in particular antidepressants and antihypertensives. A need for pharmacotherapy for sexual dysfunction is increasing, but there has been very little research effort directed at finding drugs to treat sexual dysfunction.

Sexual dysfunctions include erectile dysfunctions of organic and psychogenic origin (Benet, 1995) as well as hypoactive sexual desire disorders, sexual arousal disorders, anorgasmy and sexual pain disorders (Berman, 1999, *Urology*).

In males, impotence can be defined as an inability to achieve penile erection or ejaculation. Its prevalence is claimed to be between 2% and 7% of the human male population, increasing with age up to 50 years and between 18% and 80% between 55 and 80 years of age. In the USA alone, for example, it has been estimated that there are up to 10 million impotent males, with the majority suffering from problems of organic rather than of psychogenic origin. Although many different drugs have been shown to induce penile erection, they were only effective after direct injection into the penis e.g. intraurethrally or intracavernosally (i.c.) and were not approved for erectile dysfunction. US-A-5576290 discloses peptides which are stated to induce erection,

but they have to be given subcutaneously e.g. by injection, and if an excessive dose is given they produce an exaggerated erectile response and stomach discomfort. Impotence treatment was revolutionized by the unexpected discovery that cGMP PDE inhibitors, e.g. pyrazolo[4,3-d]pyrimidin-7-ones were useful in the treatment of  
5 erectile dysfunction and could be administered orally, therefore obviating the disadvantages associated with i.c. administration. One such compound that is currently being manufactured is sildenafil (Viagra).

Thirty to 50% of American women complain of sexual dysfunction. Ageing,  
10 menopause, and decline in circulating oestrogen levels significantly increase the incidence of sexual complaints. In a recent publication, Berman J.R. et al. (1999, *Int. J. Impot. Res.*) describe methodology for evaluating physiologic and subjective components of the female sexual response in the clinical setting and determine the effects of age and oestrogen status on them. Low or absent sexual drive/desire  
15 constitutes the commonest problem in the female population (Laumann *et al.*, 1999), but no therapy is available other than psychotherapy or empirical approaches. In a further publication (Bonney R.C et al., 2000) the causes and management of female sexual dysfunction are discussed, including the use of tibolone (Livial; Organon) which is a synthetic steroid that mimics the effects of oestrogen and has been reported  
20 to have mild androgenic properties, and the use of testosterone.

So far in the UK and the USA no drug has been licensed by the Department of Health specifically for the treatment of female sexual dysfunction, hence there is an unmet medical need in the treatment of female sexual dysfunction, especially sexual  
25 drive problems.

## SUMMARY OF THE INVENTION

This invention is based on the realisation that substances that act as bombesin  
30 receptor antagonists have utility in the treatment of sexual dysfunction, including the behavioural component thereof, in both male and female subjects. In other words, they can provide a treatment, in males, for erectile dysfunctions of organic and

psychogenic origin as well as hypoactive sexual desire disorders, sexual arousal disorders, anorgasmia and sexual pain disorders in females.

5 The invention therefore provides a method of treating sexual dysfunction which comprises administering to a subject suffering therefrom and in need of treatment an effective amount of a bombesin (BB) receptor antagonist.

The invention further provides the use of a bombesin receptor antagonist in the manufacture of a medicament for preventing or treating male sexual dysfunction or  
10 female sexual dysfunction.

Furthermore, many of the compounds that can be used in this invention have both the property of binding to bombesin receptors and the property that an effective dose can be administered orally.

15

The bombesin antagonists preferably have a  $K_i$  against the bombesin receptor of less than 1000nM, preferably less than 500nM, more preferably less than 100 nM, preferably less than 50 nM and most preferably less than 10 nM. Preferably the bombesin antagonists are selective for  $BB_1$  over the other bombesin receptor subtypes  
20 (preferably a selectivity of greater than 10, and more preferably a selectivity greater than 30 and most preferably greater than 100 measurable *in vitro* by the ratio of their  $IC_{50}$  or  $K_i$  values against the  $BB_1$  and  $BB_2$  receptors respectively) and has a  $K_i$  against the  $BB_1$  receptor of less than 1000nM, preferably less than 500nM, more preferably less than 100 nM, preferably less than 50 nM and most preferably less than  
25 10 nM. Compounds having the potencies set out above can be identified by the *in vitro* screen described below.

Thus the invention provides a method of treating drug induced sexual dysfunction (particularly but not exclusively dysfunction induced by antidepressants)  
30 in a male comprising administering to a male suffering therefrom an effective amount of a bombesin  $BB_1$  antagonist or a mixed  $BB_1/BB_2$  antagonist.

The invention further provides a method of treating drug induced sexual dysfunction (particularly but not exclusively dysfunction induced by antidepressants) in a female comprising administering to a female suffering therefrom an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist.

5

The invention also provides a method for treating erectile dysfunction in a male comprising administering to a male suffering therefrom an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist .

10

The invention also provides a method for treating a female patient suffering from hypoactive sexual desire disorder comprising administering to the female patient an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist.

15 The invention also provides a method for treating a female patient suffering from sexual arousal disorder and/or orgasmic disorder comprising administering to the female patient an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist.

20 The present invention additionally comprises the combination of a bombesin receptor antagonist (which may have one of the preferred range of potencies indicated above) for the treatment of male sexual dysfunction as outlined herein (more particularly male erectile dysfunction) and female sexual dysfunction (as outlined herein, more particularly female sexual arousal disorder or female sexual desire disorder) with one or more of the following auxiliary active agents. The combination  
25 provides a treatment for erectile dysfunctions of organic, neurogenic and/or psychogenic origin as well as hypoactive sexual desire disorders, sexual arousal disorders, anorgasmic and sexual pain disorders

30 Thus a further aspect of the invention provides a pharmaceutical combination (for simultaneous, separate or sequential administration) of a bombesin receptor antagonist according to the invention and one or more materials selected from (1) to (34) below:

- (1) naturally occurring or synthetic prostaglandins or esters thereof;
- (2)  $\alpha$  - adrenergic receptor antagonist compounds also known as  $\alpha$  - adrenoceptor antagonists or  $\alpha$ -receptor antagonists or  $\alpha$ -blockers;
- (3) NO-donor (NO-agonist) compounds;
- 5 (4) potassium channel openers or modulators;
- (5) dopaminergic agents;
- (6) vasodilator agents;
- (7) thromboxane A2 agonists;
- (8) CNS active agents;
- 10 (9) ergot alkaloids;
- (10) compounds which modulate the action of natriuretic factors;
- (11) angiotensin receptor antagonists such as losartan;
- (12) substrates for NO-synthase;
- (13) calcium channel blockers;
- 15 (14) cholesterol lowering agents;
- (15) antiplatelet and antithrombotic agents;
- (16) insulin sensitising agents and hypoglycaemic agents;
- (17) L-DOPA or carbidopa;
- (18) acetylcholinesterase inhibitors;
- 20 (19) steroidal or non-steroidal anti-inflammatory agents;
- (20) estrogen receptor modulators and/or estrogen agonists and/or estrogen antagonists, and pharmaceutically acceptable salts thereof;
- (21) PDE inhibitors;
- (22) NPY (neuropeptide Y) inhibitors;
- 25 (23) NEP inhibitors;
- (24) vasoactive intestinal proteins (VIP), VIP mimetics, VIP analogues, VIP receptor agonists or VIP analogues or VIP fragments, or  $\alpha$ -adrenoceptor antagonists with VIP combinations;
- (25) melanocortin receptor agonists or modulators or melanocortin enhancers;
- 30 (26) serotonin receptor agonists, antagonists or modulators;
- (27) testosterone replacement agents, testosterone, dihydrotestosterone or a testosterone implant;

- (28) estrogen, estrogen and medroxyprogesterone or medroxyprogesterone acetate (MPA) (i.e. as a combination), or estrogen and methyl testosterone hormone replacement therapy agents;
- (29) modulators of transporters for noradrenaline, dopamine and/or serotonin;
- 5 (30) purinergic receptor agonists and/or modulators;
- (31) neurokinin (NK) receptor antagonists;
- (32) opioid receptor agonists, antagonists or modulators;
- (33) agonists or modulators for oxytocin/vasopressin receptors; and
- (34) modulators of cannabinoid receptors.

10

In particular the invention includes a pharmaceutical composition or a unit dosage form comprising an effective amount of a bombesin receptor antagonist and an effective amount of any of the materials selected from (1) to (34) above.

15

In the above methods, and in the above combination, composition or dosage form, said antagonists preferably have a  $K_i$  against  $BB_1$ , of less than 1000nM, preferably less than 500nM, more preferably less than 100 nM, preferably less than 50 nM and most preferably less than 10 nM and/or a selectivity for  $BB_1$  over the other

20 bombesin receptor subtypes greater than 10, and more preferably greater than 30 and most preferably greater than 100 measurable *in vitro* by the ratio of their  $IC_{50}$  or  $K_i$  values against the  $BB_1$  and  $BB_2$  receptors respectively.

### BRIEF DESCRIPTION OF FIGURES

25

**Figure 1:** Effect of (S) 3-(1H-Indol-3-yl)-N-[1-(5-methoxy-pyridin-2-yl)-cyclohexyl-methyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide (Compound (1)) on female rat sexual proceptivity.

30

**Figure 2:** Effect of Compound (1) on female rat sexual receptivity.



**Figure 3:** Effect of repeated administration of Compound (1) on female rat proceptivity.

**Figure 4:** Effect of intracerebroventricular administration of Compound (1) on female  
5 rat sexual proceptivity.

**Figure 5:** Inhibitory effect of NMB on female rat sexual proceptivity and antagonism of this effect by Compound (1).

10 **Figure 6:** Results of an investigation to show whether the effect of Compound (1) on female sexual behaviour is mediated through progesterone.

**Figure 7:** Results of an investigation to show whether the effect of Compound (1) on female sexual behaviour is mediated through oestradiol.

15

**Figure 8:** Results of an investigation to show whether the effect of Compound (1) on female sexual behaviour is mediated through prolactin.

**Figure 9:** Results of an investigation to show whether the effect of Compound (1) on  
20 female sexual behaviour is mediated through LH.

**Figure 10:** Results of an investigation to show whether the effect of Compound (1) on female sexual behaviour is mediated through FSH.

25 **Figure 11:** Effect of Compound (1) on the sexual behaviour of normal male rats (Mount Latency).

**Figure 12:** Effect of Compound (1) on the sexual behaviour of normal male rats (Intromission Latency).

30

**Figure 13:** Effect of Compound (1) on the sexual behaviour of normal male rats (Number of Mounts + Intromission).

**Figure 14:** Effect of Compound (1) on the sexual behaviour of normal male rats (Ejaculation Latency).

5 **Figure 15:** Effect of Compound (1) on the sexual behaviour of normal male rats (Refractory Period).

**Figure 16:** Effect of Compound (1) on the sexual behaviour of sexually dysfunctional male rats (Mount Latency).

10

**Figure 17:** Effect of Compound (1) on the sexual behaviour of sexually dysfunctional male rats (Ejaculation Latency).

15 **Figure 18:** Effect of Compound (1) on the sexual behaviour of sexually dysfunctional male rats (% animals ejaculating).

**Figure 19:** Effect of (S)-3-(1*H*-Indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide (Compound (2)) in PEG 200 on female rat sexual proceptivity.

20

**Figure 20:** Effect of Compound (2) in methylcellulose on female rat sexual proceptivity.

**Figure 21:** Effect of Compound (2) in PEG 200 on female rat sexual receptivity.

25

**Figure 22:** Effect of compound 1 on basal and pelvic nerve-stimulated increases in female genital blood flow in the anaesthetised rabbit model of female sexual arousal.

30 **Figure 23:** Effect of (2*S*)-*N*-{[1-(4-aminophenyl)cyclohexyl]methyl}-3-(1*H*-indol-3-yl)-2-methyl-2-{[(4-nitroanilino)carbonyl]amino}propanamide (Compound 3) on basal and pelvic nerve-stimulated increases female genital blood flow in the anaesthetised rabbit model of female sexual arousal.

**Figure 24:** Effect of compound 1 on penile intracavernosal pressure in the conscious male rat.

- 5    **Figure 25:** Effect of compound 3 on penile intracavernosal pressure in the conscious male rat model of penile erection.

**Figure 26:** Effect of compound 3 alone and in combination with a phosphodiesterase type five inhibitor on basal and pelvic nerve-stimulated increases penile  
10    intracavernosal pressure in the anaesthetised rabbit model of penile erection.

## DESCRIPTION OF PREFERRED EMBODIMENTS

### Suitable subjects

15

As previously explained the invention provides combinations, compositions and methods for the treatment of male sexual dysfunction or female sexual dysfunction. The inventors believe that there are common mechanisms underlying the pathologies of male and female psychogenic sexual dysfunctions.

20

Male sexual dysfunction includes male erectile dysfunction (MED). Patients with mild to moderate MED should benefit from treatment with a bombesin antagonist and patients with severe MED should also respond. the ability of bombesin antagonists to return intracavernosal pressure to normal levels in a conscious rat  
25    model of penile erection (Example 170, Figs. 24 and 25) and in a pelvic nerve stimulation model (Example 171, Fig 26) has been demonstrated using telemetry. However, early investigations suggest that the response rate of patients with mild, moderate and severe MED will be greater with a bombesin antagonist/PDE5 inhibitor combination (see Example 171 and Fig. 26). Mild, moderate and severe MED will be  
30    terms known to the man skilled in the art, but guidance can be found in *The Journal of Urology*, vol 151, 54-61 (Jan 1994).

- Our investigations suggest the below mentioned male sexual dysfunction/MED patient groups should benefit from treatment with a bombesin antagonist and/or a bombesin antagonist with a phosphoesterase type 5 inhibitor (PDE5i) or other combination set out herein. These patient groups which are described in more detail in
- 5 *Clinical Andrology* vol 23,no.4, p773-782, and chapter 3 of the book by I. Eardley and K. Sethia "*Erectile Dysfunction-Current Investigation and Management*", published by Mosby-Wolfe are as follows: psychogenic, endocrinologic, neurogenic, arteriogenic, drug-induced sexual dysfunction and sexual dysfunction related to cavernosal factors, particularly venogenic causes. The invention finds application in
- 10 the following sub-populations of patients with sexual dysfunction/MED: the young, the elderly including ageing-related decline in sexual arousability. More particularly, the invention finds application in patients with male sexual dysfunction such as MED arising from:-
- 15 (i) Arteriogenic/vasculogenic etiologies eg cardiovascular or atherosclerotic diseases, hypercholesterolemia, cigarette smoking, diabetes, hypertension, radiation and perineal trauma, traumatic injury to the iliohypogastric pudendal vacular system.
- 20 (ii) Neurogenic etiologies such as spinal cord injuries or diseases of the central nervous system including multiple sclerosis, diabetes, Parkinsonism, cerebrovascular accidents, peripheral neuropathies, trauma or radical pelvic surgery.
- 25 (iii) Hormonal/endocrine etiologies such as dysfunction of the hypothalamic/pituitary/gonadal axis, dysfunction of the pancreas, surgical or medical castration, androgen deficiency, high circulating levels of prolactin eg hyperprolactinemia, hyper and hypothyroidism.
- 30 (iv) Psychogenic etiologies such as depression, obsessive-compulsive disorder, anxiety disorder, emotional and relational issues, performance anxiety, marital discord, dysfunctional attitudes, sexual phobias, religious inhibition or a traumatic past experiences.
- (v) Drug-induced sexual dysfunction resulting from therapy with selective serotonin reuptake inhibitors (SSRIs) and other antidepressant therapies

(tricyclics and major tranquillizers), anti-hypertensive therapies, and sympatholytic drugs.

Drug-induced sexual dysfunction in males includes patients whose drug treatment/therapy leads to delayed ejaculation/orgasm, reduced libido and/or erectile dysfunction. The bombesin antagonists of the invention (more particularly BB1 antagonists) restore ejaculatory/orgasmic, libido and erectile function to normal physiological "levels". This is supported by the experiments described in Example 8 and Figs 16-18 below.

When the erectile dysfunction is other than drug induced, the bombesin antagonists (more particularly BB1 antagonists) can also be used to treat the erectile dysfunction by potentiating the normal endogenous erectiogenic mechanisms of the male (during normal sexual stimulation) and restoring the erectile function to normal levels during sexual stimulation. Thus Examples 170 and 171 and Figures 24, 25 and 26 hereinafter illustrate that bombesin antagonists (more particularly BB1 antagonists) or a bombesin antagonist with a phosphodiesterase type 5 inhibitor potentiate erectiogenic mechanisms in animal models by enhancing intercavernosal pressure and potentiating the effect of the pelvic nerve stimulation-induced increases in intracavernosal pressure.

Early investigations also show that that the invention will help restore the libido/desire in males to normal levels where the desire dysfunction is not drug induced (e.g. psychogenic).

The psychogenic component of male sexual dysfunction has been classified by the nomenclature committee of the International Society for Impotence Research (and is illustrated by Sachs B. D., 2000) as generalised type, characterised by a general unresponsiveness or primary lack of sexual arousal, and ageing-related decline in sexual arousability, characterised by generalised inhibition or chronic disorders of sexual intimacy.

The compounds of this invention are useful in the treatment of male sexual dysfunction, especially drug-induced male sexual dysfunction and psychogenic male sexual dysfunction associated with generalised unresponsiveness and ageing-related decline in sexual arousability.

5

Female sexual dysfunction can be grouped into four classes (Scrip's Complete Guide to Women's Healthcare, p.194-205, 2000), which include:

- 10       • Hypoactive sexual desire disorders, which can be characterised as persistent or recurrent lack of sexual thoughts/fantasies and lack of receptivity to sexual activity, causing personal distress.
- 15       • Sexual arousal disorders, which can be characterised as persistent or recurrent inability to achieve or maintain adequate sexual excitement, causing personal distress. The normal sexual arousal response consists of a number of physiological responses that are observed during sexual excitement. These changes such as vaginal, labial and clitoral engorgement result from increases in genital blood flow. Engorgement leads to increased vaginal lubrication via plasma transudation, increased vaginal compliance (relaxation of vaginal smooth muscle) and increases in vaginal and clitoral sensitivity. Female sexual arousal disorder (FSAD) is a highly prevalent sexual disorder affecting up to 20       40% of pre-, peri- and postmenopausal ( $\pm$ HRT) women. The primary consequence of FSAD is reduced genital engorgement or swelling which manifests itself as a lack of vaginal lubrication and a lack of pleasurable genital sensation. Secondary consequences include reduced sexual desire, 25       pain during intercourse and difficulty in achieving orgasm. The most common cause of FSAD is decreased genital blood flow resulting in reduced vaginal, labial and clitoral engorgement. (Park, 1997; Goldstein, 1998; Berman, 1999, Werbin, 1999).
- 30       • Orgasmic disorders can be characterised as persistent or recurrent difficulty or delay in attaining orgasm after adequate sexual stimulation and arousal, causing personal distress.

- Sexual pain disorders can be characterised by dyspareunia, (characterised by recurrent or persistent genital pain associated with sexual intercourse), vaginismus (characterised by recurrent or persistent involuntary spasm of the muscles of the outer third of the vagina which interferes with vaginal penetration, causing personal distress) and other pain disorders (characterised by recurrent or persistent genital pain induced by non coital sexual stimulation).

The compounds of this invention are useful in the treatment of female sexual dysfunction (FSD), and this includes pre-, peri- and post-menopausal female sexual dysfunction associated with hypoactive sexual desire disorders, sexual arousal disorders, orgasmic disorders or anorgasm, or sexual pain disorders.

Early investigations suggest the below mentioned female sexual dysfunction (FSD) patient groups should benefit from treatment with a bombesin antagonist or a bombesin antagonist and a PDE5i (or other combination set out hereinafter). These patient groups are described in more detail in Berman *et al* (Urology, 1999). The invention finds application in the following sub-populations of patients with FSD: the young, the elderly (ageing-related sexual dysfunction), pre-menopausal, perimenopausal, post-menopausal women with or without hormone replacement therapy. More particularly the invention finds application in patients with FSD arising from:-

- (i) Arteriogenic/vasculogenic etiologies eg cardiovascular or atherosclerotic diseases, hypercholesterolemia, cigarette smoking, diabetes, hypertension, radiation and perineal trauma, traumatic injury to the iliohypogastric pudendal vascular system.
- (ii) Neurogenic etiologies such as spinal cord injuries or diseases of the central nervous system including multiple sclerosis, diabetes, Parkinsonism, cerebrovascular accidents, peripheral neuropathies, trauma or radical pelvic surgery.
- (iii) Hormonal/endocrine etiologies such as dysfunction of the hypothalamic/pituitary/gonadal axis, or dysfunction of the ovaries, dysfunction of the pancreas, surgical or medical castration, androgen

deficiency, high circulating levels of prolactin eg hyperprolactinemia, natural menopause, premature ovarian failure, hyper and hypothyroidism.

- (iv) Psychogenic etiologies such as depression, obsessive compulsive disorder, anxiety disorder, postnatal depression/"Baby Blues", emotional and relational issues, performance anxiety, marital discord, dysfunctional attitudes, sexual phobias, religious inhibition or a traumatic past experiences.
- (v) Drug-induced sexual dysfunction resulting from therapy with selective serotonin reuptake inhibitors (SSRIs) and other antidepressant therapies (tricyclics and major tranquillizers), anti-hypertensive therapies, sympatholytic drugs, chronic oral contraceptive pill therapy.

By drug-induced sexual dysfunction in females we mean to include cases where the drug treatment/therapy leads to delayed orgasm or inability to achieve an orgasm, reduced libido and FSD. The bombesin antagonists (more particularly BB1 antagonists) help restore orgasm, libido and female sexual function to normal physiological "levels". Furthermore, since bombesin antagonists have been shown to have beneficial effects on sexual function in ovary intact and in ovariectomised animals, it is apparent that bombesin antagonists (more particularly BB1 antagonists) can also be used to treat female sexual arousal disorders (FSAD), hypoactive sexual desire disorders (HSDD) and anorgasmia (FOD) and also sexual pain disorders, especially where these are secondary to arousal disorders. In particular, Example 2 and Figures 2 and 21 and Example 169 and Figures 22 and 23 illustrate that the combinations and methods of treatment of the invention can enhance receptive behaviour and arousal via increased genital blood flow in women with FSAD and FOD respectively. Also, Examples 1, 4 and 5 and Figures 1,3, 4 and 5 illustrate that the combinations and methods of treatment of the invention can increase proceptive behaviour and restore normal desire/libido in women with HSDD.

### **Bombesin receptor antagonists - General**

Bombesin receptors are present in hypothalamic areas. We have found that they can exert a neuromodulatory effect on sexual behaviour.



We have tested compounds that are bombesin receptor antagonists using animal models that we have refined and believe are reliable and predictive, in particular with the capacity to make predictions for females. In rodents proceptive behaviour is under hormonal control, progesterone being essential for induction of proceptive behaviour in combination with oestrogen (Johnson M, 1988). The evidence for the hormonal control of proceptive behaviour in primates is conflicting, but on the whole oestrogens and/or androgens appear to enhance proceptive behaviour (Baum M.J, 1983). The behavioural manifestations of proceptive behaviour in the rat include "hopping and darting" movement, with rapid vibration of the ears. Tests to assess the eagerness to seek sexual contact (sexual motivation) have been reported as the most appropriate way to measure proceptivity (Meyerson, 1973). Receptivity, in the rat, is demonstrated when the female assumes a lordotic position. This occurs when, on mounting, the male exerts pressure with his forepaws on the flanks of the receptive female. The main sites of neuronal control for this behaviour are the ventromedial nucleus (VMN) and the midbrain central grey area (MCG) (for review, see Wilson C.A., 1993).

Bombesin is a 14-amino acid peptide originally isolated from the skin of the European frog *Bombina bombina* (Anastasi A., 1971). It belongs to a class of peptides which share structural homology in their C-terminal decapeptide region (Dutta A.S., *Small Peptides; Chemistry, Biology, and Clinical Studies*). At present, two mammalian bombesin-like peptides have been identified, the decapeptide neuromedin B (NMB) and a 23-residue amino acid, gastrin-releasing peptide (GRP).

Bombesin evokes a number of central effects through actions at a heterogeneous population of receptors. The BB<sub>1</sub> receptor binds neuromedin B (NMB) with higher affinity than gastrin-related peptide (GRP) and neuromedin C (NMC) and BB<sub>2</sub> receptors bind GRP and NMC with greater affinity than NMB. More recently evidence has emerged of two more receptor subtypes denoted BB<sub>3</sub> and BB<sub>4</sub> but due to limited pharmacology, little is known of their function at present. BB<sub>1</sub> and BB<sub>2</sub> receptors have a heterogeneous distribution within the central nervous system

indicating that the endogenous ligands for these receptors may differentially modulate neurotransmission. Among other areas, BB<sub>1</sub> receptors are present in the ventromedial hypothalamus (Ladenheim E.E, 1990).

- 5           Bombesin-like immunoreactivity and mRNA have been detected in mammalian brain (Braun M., et al., 1978, Battey J., et al.1991). NMB and GRP are believed to mediate a variety of biological actions (for a review, see WO 98/07718).

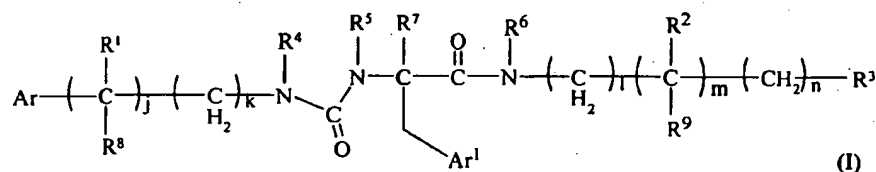
          The following patent applications disclose compounds capable of antagonising  
10   the effects of NMB and/or GRP at bombesin receptors: CA 2030212, EP 0309297, EP 0315367, EP 0339193, EP 0345990, EP 0402852, EP 0428700, EP 0438519, EP 0468497, EP 0559756, EP 0737691, EP 0835662, JP 07258081, UK 2231051, US 4943561, US 5019647, US 5028692, US 5047502, US 5068222, US 5084555, US 5162497, US 5244883, US 5439884, US 5620955, US 5620959, US 5650395, US  
15   5723578, US 5750646, US 5767236, US 5877277, US 5985834, WO 88/07551, WO 89/02897, WO 89/09232, WO 90/01037, WO 90/03980, WO 91/02746, WO 91/04040, WO 91/06563, WO 92/02545, WO 92/07830, WO 92/09626, WO 92/20363, WO 92/20707, WO 93/16105, WO 94/02018, WO 94/02163, WO 94/21674, WO 95/00542, WO 96/17617, WO 96/28214, WO 97/09347, WO  
20   98/07718, WO 00/09115, WO 00/09116. We believe that compounds disclosed in these applications can be used in the prevention or treatment of male and/or female sexual dysfunction, which is an indication that is not disclosed or suggested by the aforesaid applications, or indeed in any previous scientific publication concerning bombesin receptors.

25

          Bombesin receptor antagonists to which this invention is applicable include both non-peptide compounds and peptide compounds. Compounds that can be formulated into compositions for oral administration, especially human oral administration, without substantial loss of activity are preferred. Many non-peptide  
30   compounds having the desired properties fall into this category.

### A) Non-peptide bombesin receptor antagonists

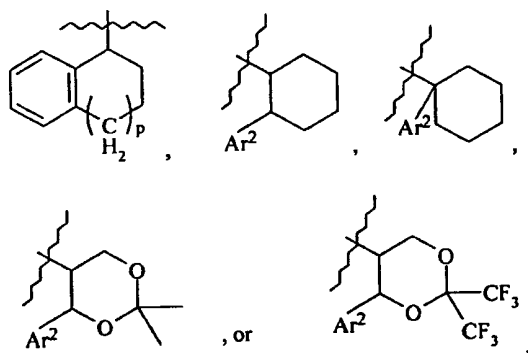
One preferred genus of compounds for use in the invention comprises bombesin receptor antagonists of the formula (I)



and pharmaceutically acceptable salts thereof, wherein:

- j is 0 or 1;
- k is 0 or 1;
- 10   • l is 0, 1, 2, or 3;
- m is 0 or 1;
- n is 0, 1 or 2;
- Ar is phenyl, pyridyl or pyrimidyl, each unsubstituted or substituted by from 1 to 3 substituents selected from alkyl, halogen, alkoxy, acetyl, nitro, amino, -CH<sub>2</sub>NR<sup>10</sup>R<sup>11</sup>, cyano, -CF<sub>3</sub>, -NHCONH<sub>2</sub>, and -CO<sub>2</sub>R<sup>12</sup>;
- 15   • R<sup>1</sup> is hydrogen or straight, branched, or cyclic alkyl of from 1 to 7 carbon atoms;
- R<sup>8</sup> is hydrogen or forms a ring with R<sup>1</sup> of from 3 to 7 carbon atoms;
- R<sup>2</sup> is hydrogen or straight, branched, or cyclic alkyl of from 1 to 8 carbon atoms which can also contain 1 to 2 oxygen or nitrogen atoms;
- 20   • R<sup>9</sup> is hydrogen or forms with R<sup>2</sup> a ring of from 3 to 7 carbon atoms which can contain an oxygen or nitrogen atom; or R<sup>2</sup> and R<sup>9</sup> can together be a carbonyl;
- Ar<sup>1</sup> can be independently selected from Ar and can also include pyridyl-N-oxide, indolyl, imidazolyl, and pyridyl;
- 25

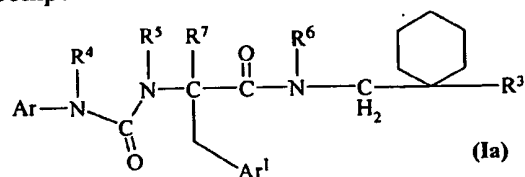
- $R^4$ ,  $R^5$ ,  $R^6$ , and  $R^7$  are each independently selected from hydrogen and lower alkyl;  $R^4$  can also form with  $R^5$  a covalent link of 2 to 3 atoms which may include an oxygen or a nitrogen atom;
- $R^3$  can be independently selected from Ar or is hydrogen, hydroxy,  $-NMe_2$ ,  
 5 N-methyl-pyrrolyl, imidazolyl, N-methyl-imidazolyl, tetrazolyl, N-methyl-tetrazolyl, thiazolyl,  $-CONR^{13}R^{14}$ , alkoxy,



wherein p is 0, 1 or 2 and  $Ar^2$  is phenyl or pyridyl;

- $R^{10}$ ,  $R^{11}$ ,  $R^{12}$ ,  $R^{13}$  and  $R^{14}$  are each independently selected from hydrogen or  
 10 straight, branched, or cyclic alkyl of from 1 to 7 carbon atoms.

Preferred compounds are those of Formula (Ia)

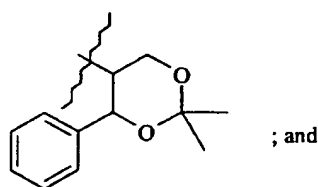


wherein

- Ar is phenyl unsubstituted or substituted with 1 or 2 substituents selected from isopropyl, halo, nitro, and cyano;
- $R^4$ ,  $R^5$ , and  $R^6$  are hydrogen;
- $R^7$  is methyl or hydrogen;
- $R^3$  is 2-pyridyl or hydroxy; and
- $Ar^1$  is indolyl, pyridyl, pyridyl-N-oxide, or imidazolyl.

Other preferred compounds are those of Formula I wherein

- Ar is unsubstituted phenyl;
- R<sup>1</sup> is cyclopentyl or *tert*-butyl;
- R<sup>4</sup> and R<sup>5</sup> are hydrogen;
- 5 • R<sup>7</sup> is methyl;
- R<sup>6</sup> is hydrogen;
- R<sup>3</sup> is phenyl with two isopropyl substituents, unsubstituted phenyl, or

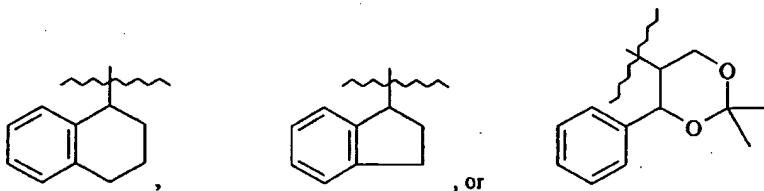


Ar<sup>1</sup> is indolyl.

10

Other preferred compounds are those of Formula I wherein

- Ar is 2,6-diisopropyl-phenyl, 4-nitro-phenyl, and 4-cyano-phenyl;
- R<sup>4</sup>, R<sup>5</sup>, and R<sup>6</sup> are hydrogen;
- R<sup>7</sup> is methyl;
- 15 • R<sup>2</sup> is hydrogen or cyclohexyl; and
- R<sup>3</sup> is hydroxyl, pyridyl,



20

At present, most preferred of the compounds of formula (I) are (S) 3-(1H-Indol-3-yl)-N-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide (also referred to as Compound 1) and its pharmacologically acceptable salts and (2S)-N-{[1-(4-aminophenyl)cyclohexyl]methyl}-3-(1*H*-indol-3-yl)-2-methyl-2-[[4-nitroanilino]-

carbonyl]amino}propanamide (also referred to as Compound **3**) and its pharmacologically acceptable salts.

Other preferred compounds of Formula (I) are set out below and included also  
5 are their pharmaceutically acceptable salts:

(S) *N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-  
2-methyl-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-  
*N*-methyl-propionamide;

10 *N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-1-methyl-ureido]-3-(1*H*-  
indol-3-yl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-(1-oxy-pyridin-2-yl)-*N*-(1-  
pyridin-2-yl-cyclohexylmethyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-pyridin-2-yl-*N*-(1-pyridin-2-  
15 yl-cyclohexylmethyl)-propionamide;

2-[3-(2-*tert*-butyl-phenyl)-ureido]-*N*-cyclohexylmethyl-3-(1*H*-indol-3-yl)-2-  
methyl-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,6-dichloro-phenyl)ureido]-3-(1*H*-indol-3-yl)-2-  
methyl-propionamide;

20 *N*-cyclohexylmethyl-2-[3-(2,6-dimethoxy-phenyl)ureido]-3-(1*H*-indol-3-yl)-2-  
methyl-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,6-dimethylamino-phenyl)-ureido]-3-(1*H*indol-3-  
yl)-2-methyl-propionamide;

(S) *N*-cyclohexylmethyl-3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-  
25 ureido]-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,2-dimethyl- 1 -phenyl)propyl)-ureido]-3-(1*H*-  
indol-3-yl)-2-methyl-propionamide;

[S-(R\*, R\*)] 3-(1*H*-indol-3-yl)-2-methyl-2-{3-[1-(4-nitro-phenyl)-ethyl]-  
ureido}-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

30 *N*-(2,2-dimethyl-4-phenyl-[1,3]dioxan-5-yl)-3-(1*H*-indol-3-yl)-2-methyl-2-[3-  
(1-phenyl-cyclopentylmethyl)ureido]-propionamide;

(S)-*N*-(2,6-diisopropyl-phenyl)-2-[3-(2,2-dimethyl-1-phenyl-propyl)-ureido]-3-(1*H*-indol-3-yl)-propionamide;

(R)-*N*-(2,6-diisopropyl-phenyl)-2-[3-(2,2-dimethyl-1-phenyl-propyl)-ureido]-3-(1*H*-indol-3-yl)-propionamide;

5        2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-(2,2-dimethyl-4-phenyl-[1,3]dioxan-5-yl)-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

*N*-cyclohexyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

10        *N*-(2-cyclohexyl-ethyl)-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(3-methyl-butyl)-propionamide;

15        2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(3-phenyl-propyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1,2,3,4-tetrahydro-naphthalen-1-yl)-propionamide;

20        2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(2-phenyl-cyclohexyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-indan-1-yl-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-(1-hydroxy-cyclohexylmethyl)-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

25        2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(6,7,8,9-tetrahydro-5*H*-benzocyclohepten-5-yl)-propionamide;

30        2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-phenyl-propionamide;

*N*-(1-hydroxy-cyclohexylmethyl)-3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide;

2-[3-(4-cyano-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(*S*) 3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

5 (*S*) 3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-[3-(4-trifluoromethyl-phenyl)-ureido]-propionamide;

(*S*) 4-(3-{2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-ureido)-benzoic acid ethyl ester;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-imidazol-4-yl)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

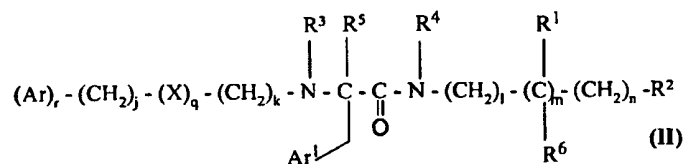
2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-3-(2-trifluoromethyl-phenyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-(2-nitro-phenyl)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

15 (*S*) 3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide; and

*N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-pyridin-2-yl-propionamide.

20 Another preferred genus of compounds which can be used for the present purpose is of formula (II) and includes pharmaceutically acceptable salts thereof:



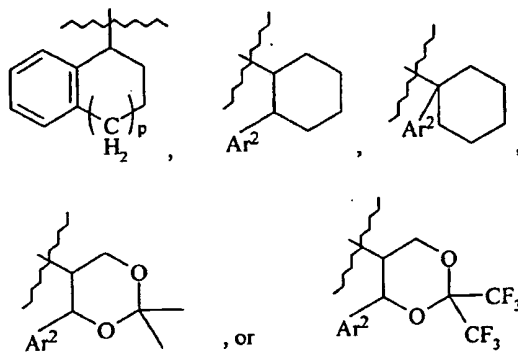
wherein:

- 25
- *j* is 0, 1 or 2;
  - *k* is 0 or 1;
  - *l* is 0, 1, 2, or 3;
  - *m* is 0 or 1;
  - *n* is 0, 1 or 2;



- q is 0 or 1;
- r is 0 or 1; when r is 0, Ar is replaced by hydrogen;
- Ar is phenyl, pyridyl, pyrimidyl, thienyl, furyl, imidazolyl, pyrrolyl or thiazolyl each unsubstituted or substituted by from 1 to 3 substituents selected from acetyl, alkoxy, alkyl, amino, cyano, halo, hydroxy, nitro, sulfonamido, sulfonyl, -CF<sub>3</sub>, -OCF<sub>3</sub>, -CO<sub>2</sub>H, -CH<sub>2</sub>CN, -SO<sub>2</sub>CF<sub>3</sub>, -CH<sub>2</sub>CO<sub>2</sub>H and - (CH<sub>2</sub>)<sub>s</sub>NR<sup>7</sup>R<sup>8</sup> wherein s is 0, 1, 2 or 3 and R<sup>7</sup> and R<sup>8</sup> are each independently selected from H, straight or branched alkyl of up to 6 carbon atoms, or R<sup>7</sup> and R<sup>8</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-membered aliphatic ring which may contain 1 or 2 oxygen atoms;
- R<sup>1</sup> is hydrogen, straight or branched alkyl of up to 6 carbon atoms or cycloalkyl of between 5 and 7 carbon atoms which may contain 1 or 2 nitrogen or oxygen atoms;
- R<sup>6</sup> is hydrogen, methyl, or forms with R<sup>1</sup> an aliphatic ring of from 3 to 7 atoms which can contain an oxygen or nitrogen atom, or together with R<sup>1</sup> is a carbonyl group;
- Ar<sup>1</sup> is independently selected from Ar or is indolyl or pyridyl-N-oxide;
- R<sup>3</sup>, R<sup>4</sup>, and R<sup>5</sup> are each independently selected from hydrogen and lower alkyl;
- R<sup>2</sup> is independently selected from Ar or is hydrogen, hydroxy, alkoxy, -NMe<sub>2</sub>, -CONR<sup>9</sup>R<sup>10</sup> wherein R<sup>9</sup> and R<sup>10</sup> are each independently selected from hydrogen, straight or branched alkyl of up to 6 carbon atoms, or R<sup>9</sup> and R<sup>10</sup> together with the nitrogen atom to which they are linked can form a 5-to 7-membered aliphatic ring which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>2</sup> is

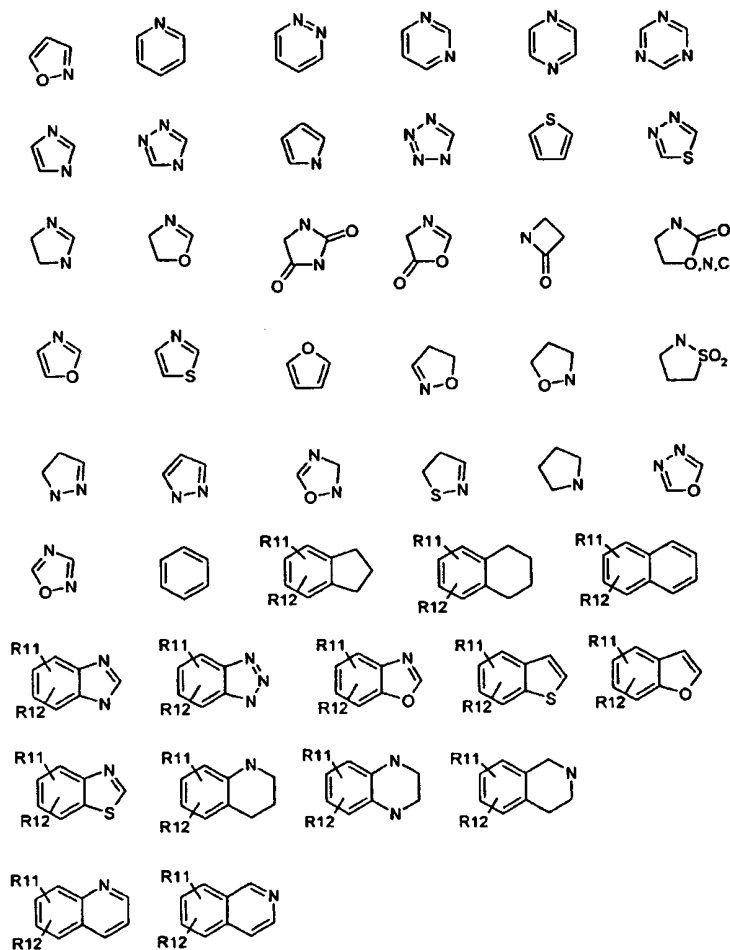
24



wherein  $p$  is 0, 1 or 2 and  $\text{Ar}^2$  is phenyl or pyridyl;

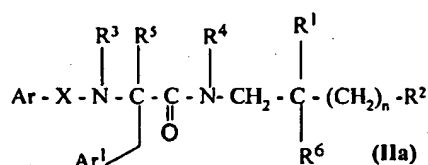
- $X$  is a divalent radical derived from any of the following

5



where the ring nitrogen atoms may have lower alkyl groups attached thereto,  $R^{11}$  and  $R^{12}$  are independently selected from H, halogen, hydroxy, alkoxy, acetyl, nitro, cyano, amino,  $CF_3$  and  $-(CH_2)_tNR^{13}R^{14}$  where  $t$  can be 0 or 1,  $R^{13}$  and  $R^{14}$  are each independently selected from hydrogen, straight or branched alkyl of up to 6 carbon atoms or cycloalkyl of 5 to 7 carbon atoms, containing up to 2 oxygen or nitrogen atoms.

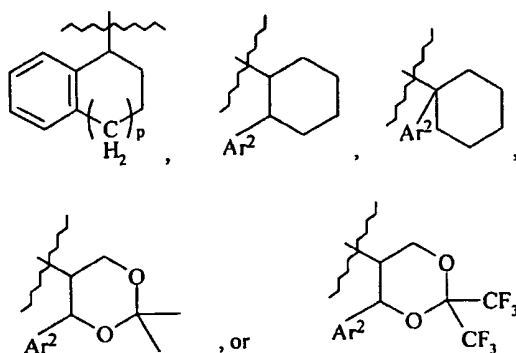
A preferred species of compounds within the genus defined by formula (II) is represented by the formula (IIa), and includes pharmaceutically acceptable salt thereof:



wherein:

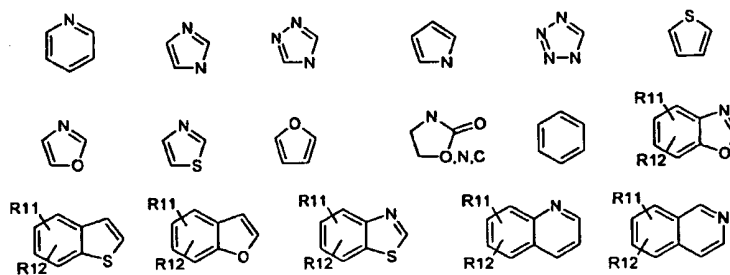
- $n$  is 0 or 1;
- Ar is phenyl or pyridyl which may be unsubstituted or substituted with from 1 to 3 substituents selected from halogen, alkoxy, nitro and cyano;
- $\text{Ar}^1$  is independently selected from Ar or is pyridyl-*N*-oxide or indolyl;
- $R^6$  forms with  $R^1$  an aliphatic ring of from 3 to 7 atoms which can contain an oxygen or nitrogen atom, or together with  $R^1$  is a carbonyl group;
- $R^2$  is independently selected from Ar or is hydrogen, hydroxy, alkoxy, dimethylamino, tetrazolyl or  $-\text{CONR}^9\text{R}^{10}$  wherein  $R^9$  and  $R^{10}$  are each independently selected from hydrogen or methyl or  $R^2$  is any of

26



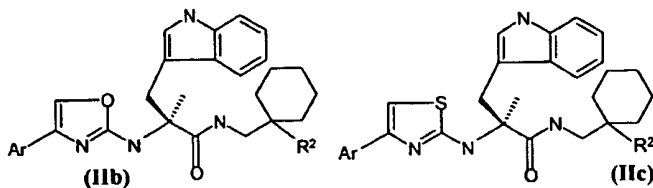
wherein  $p$  is 0, 1 or 2 and  $Ar^2$  is phenyl or pyridyl;

- $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from hydrogen and methyl;
- $X$  is selected from:



$R^{11}$  and  $R^{12}$  being independently selected from H, halogen, hydroxy, alkoxy, acetyl, nitro, cyano, amino,  $CF_3$  and  $(CH_2)_tNR^{13}R^{14}$  wherein  $t$  is 0 or 1 and  $R^{13}$  and  $R^{14}$  are independently selected from hydrogen and methyl.

A sub-species of preferred compounds within the general formula (II) has the formula (IIb) or (IIc):

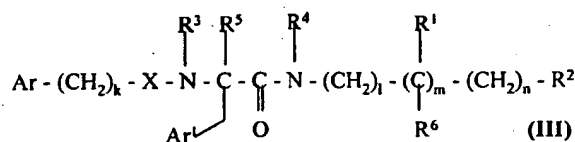


wherein Ar and R<sup>2</sup> independently represent phenyl or pyridyl which may be unsubstituted or substituted with from 1 to 3 substituents selected from halogen, alkoxy, nitro and cyano, and pharmaceutically acceptable salts thereof.

- 5 A particularly preferred compound falling within formula (II) is (S)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide (also referred to as Compound **2**) and its pharmaceutically acceptable salts.

- 10 Other preferred compounds falling within formula (II) are described below in Examples 10-27 and are included within the invention, as also are their pharmaceutically acceptable salts.

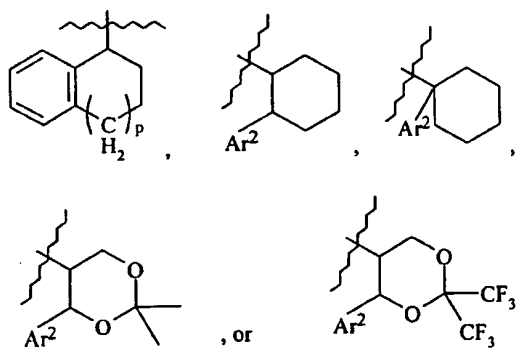
- 15 A third genus of bombesin receptor antagonists according to the invention has the formula (III) and include pharmaceutically acceptable salts thereof:



wherein:

- 20
- k is 0, 1 or 2;
  - l is 0, 1, 2 or 3;
  - m is 0 or 1;
  - n is 0, 1 or 2;
  - X is -CO-, -OCO-, -SO- and -SO<sub>2</sub>-;
- 25
- Ar is benzimidazolyl, benzofuryl, benzothiadiazolyl, benzothiazolyl, benzothienyl, benzopyrazinyl, benzotriazolyl, benzoxadiazolyl, furyl, imidazolyl, indanyl, indolyl, isoquinolyl, isoxazolyl, naphthyl, oxazolyl, phenyl, pyrazinyl, pyrazolyl, pyridyl, pyridazinyl, pyrimidyl, pyrrolyl, quinoliny, tetralinyl, tetrazolyl, thiazolyl, thienyl or triazolyl each

- unsubstituted or substituted with from 1 to 3 substituents selected from amino, acetyl, alkyl (straight chain or branched with from 1 to 6 carbon atoms), alkoxy, cyano, halogen, hydroxy, nitro, phenyl, pyridyl, pyrrolyl, isoxazolyl, phenoxy, tolyloxy, -CF<sub>3</sub>, -OCF<sub>3</sub>, -SO<sub>2</sub>CF<sub>3</sub>, -NHCONH<sub>2</sub>, -CO<sub>2</sub>H, -CH<sub>2</sub>CO<sub>2</sub>H, -CH<sub>2</sub>CN, SO<sub>2</sub>Me, SO<sub>2</sub>NH<sub>2</sub>, SO<sub>2</sub>Ph, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, -CONR<sup>9</sup>R<sup>10</sup>, and CO<sub>2</sub>R<sup>11</sup>,  
 5 wherein q is 0, 1 or 2 and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup>, R<sup>11</sup> are each independently selected from hydrogen or straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 to 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms or R<sup>7</sup> and R<sup>8</sup> or R<sup>9</sup> and R<sup>10</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-membered aliphatic ring which may contain  
 10 1 or 2 oxygen or nitrogen atoms;
- Ar<sup>1</sup> is independently selected from Ar and can also be pyridyl-*N*-oxide;
  - R<sup>1</sup> is hydrogen or straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 and 7 atoms which may contain 1 or 2 oxygen or nitrogen  
 15 atoms;
  - R<sup>2</sup> is independently selected from Ar or is hydrogen, hydroxy, alkoxy, -NMe<sub>2</sub>, -CONR<sup>12</sup>R<sup>13</sup>,



- wherein p is 0, 1 or 2, Ar<sup>2</sup> is phenyl or pyridyl; and, R<sup>12</sup> and R<sup>13</sup> are each  
 20 independently selected from hydrogen, straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 and 7 carbon atoms;
- R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are each independently selected from hydrogen and lower alkyl;  
 and

- $R^6$  is hydrogen, methyl or forms with  $R^1$  a ring of from 3 to 7 carbon atoms which can contain an oxygen or nitrogen atom, or  $R^1$  and  $R^6$  can together be carbonyl.

5 In a preferred group of the compounds of formula (III):

- $k$  is 0 or 1;
- $l$  is 1;
- $m$  is 0 or 1;
- $n$  is 0 or 1;
- 10 •  $X$  is  $-C(O)-$ ,  $-OC(O)-$ , or  $-SO_2-$ ;
- $Ar$  is benzofuryl, furyl, indolyl, isoquinolyl, naphthyl, phenyl, pyridyl, quinolyl or thienyl each unsubstituted or substituted with 1 or 2 substituents selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy,  $-CF_3$ ,  $-(CH_2)_qNR^7R^8$ , wherein  $R^7$  and  $R^8$  can form a ring of between 5 to 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms, or  $R^7$  and  $R^8$  can be independently selected from hydrogen, straight or branched alkyl of up to 4 carbon atoms or cyclic alkyl of 5 carbon atoms;
- 15 •  $Ar^1$  is independently selected from  $Ar$ , preferably indolyl, and can also be pyridyl-*N*-oxide;
- 20 •  $R^1$  and  $R^6$  can form a cyclic alkyl of from 5 to 7 carbon atoms or  $R^1$  and  $R^6$  together are carbonyl;
- $R^2$  is independently selected from unsubstituted or substituted pyridyl or is hydrogen, hydroxy, alkoxy,  $-NMe_2$ ,  $-CONR^{12}R^{13}$  wherein  $R^{12}$  and  $R^{13}$  are each independently selected from H and  $CH_3$ ;
- 25 •  $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from hydrogen and methyl.

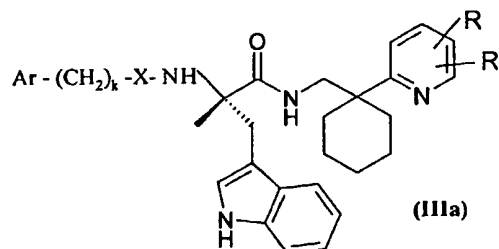
In another preferred group of the compounds of Formula (III),

- $l$  is 1;
- $m$  is 1;
- 30 •  $n$  is 0;
- $R^2$  is 2-pyridyl;

- $R^6$  forms a cyclohexyl with  $R^1$ .

A particularly preferred group of compounds is of formula (IIIa):

5



wherein Ar, k and X have the meanings given above in first, and the pyridine ring is optionally substituted by with 1 or 2 substituents, R and R', independently selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy, -CF<sub>3</sub>, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, wherein R<sup>7</sup> and R<sup>8</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-membered aliphatic ring which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>7</sup> and R<sup>8</sup> can be independently selected from hydrogen or cyclic alkyl of between 5 to 7 carbon atoms, and their pharmaceutically acceptable salts thereof.

In a further set of compounds (IIIa), Ar is benzofuryl, furyl, indolyl, isoquinolyl, naphthyl, phenyl, pyridyl, quinolyl or thienyl each unsubstituted or substituted with 1 or 2 substituents selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy, -CF<sub>3</sub>, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, wherein R<sup>7</sup> and R<sup>8</sup> can form a ring of between 5 to 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>7</sup> or R<sup>8</sup> can be a independently selected from hydrogen or cyclic alkyl of 5 carbon atoms, and X is -C(O)-, -OC(O)- or -SO<sub>2</sub>.

#### Preferred *N*-terminal amide derivatives of the compounds of formula (III)

Amongst *N*-terminal amide derivatives, i.e. compounds of formula (III) wherein X is -C(O)-, the following compounds are most preferred:



*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-nitro-benzamide;

*C*-dimethylamino-*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide;

5        1*H*-indole-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

benzo[b]thiophene-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

10        *N*-{(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-pyrrol-1-yl-benzamide

1*H*-indole-5-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide; and

1*H*-indole-2-carboxylic acid ((S)-2-(1*H*-indol-3-yl)-1-[[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-carbamoyl]-1-methyl-ethyl)-amide.

15

Other preferred *N*-terminal amide derivatives of formula (III) include the compounds of Examples 32-35, 37-47, 49-60, 62-80, 82-85 and *N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-pyrrol-1-yl-benzamide.

20

#### **Preferred *N*-terminal urethane derivatives of the compounds of formula (III)**

Amongst *N*-terminal urethane derivatives, i.e. compounds of formula III wherein X is -OC(=O)-, the following compounds and their pharmaceutically acceptable salts are particularly preferred:

25

{(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid naphthalen-1-ylmethyl ester;

{(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3,4-dichloro-benzyl ester;

30

{(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 4-nitro-benzyl ester;

{(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-nitro-benzyl ester;

{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-cyano-benzyl ester;

{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-trifluoromethyl-benzyl ester;

5        {(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2,3-dichloro-benzyl ester; and

{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid quinolin-6-ylmethyl ester.

10        Other preferred *N*-terminal urethane derivatives of formula (III) include the compounds of Examples 88-90, 92-95, 97-98, 100-102, 104-106 and 108.

**Preferred *N*-terminal sulfonamide derivatives of the compounds of formula (III)**

15        Amongst *N*-terminal sulfonamide derivatives of formula (III) (compounds of formula (III) wherein X is -SO<sub>2</sub>-) the following compounds are particularly preferred:

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-phenylmethanesulfonylamino-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

20        (S)-2-(2-chloro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(naphthalene-1-sulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(quinoline-8-sulfonylamino)-propionamide;

25        (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-trifluoromethyl-benzenesulfonylamino)-propionamide;

(S)-2-(biphenyl-2-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

30        (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(5-methyl-2-phenoxy-benzenesulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide; and

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-*p*-tolylloxy-benzenesulfonylamino)-propionamide.

35        Further preferred *N*-terminal sulfonamide derivatives of formula (III) include the compounds of Examples 112, 114, 116-119, 121-128, 130-151, 155-168 and the following:

(S)-3-(1*H*-indol-3-yl)-2-methanesulfonylamino-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide; and

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2,2,2-trifluoro-ethanesulfonylamino)-propionamide.

5

The compounds of the general formulae above are optically active. The scope of the invention therefore also includes:

- All stereoisomers of the compounds of the above general formulae.
- The solvates, hydrates and polymorphs (different crystalline lattice descriptors) of the above compounds.
- Pharmaceutical compositions of the above compounds.
- Prodrugs of the above compounds such as would occur to a person skilled in the art; see Bundgaard et al (1987).

10

15

The alkyl groups contemplated by the invention include straight, branched, or cyclic carbon chains of from 1 to 8 carbon atoms except where specifically stated otherwise. Representative groups are methyl ethyl, propyl, isopropyl, *n*-propyl, *n*-butyl, iso-butyl, sec-butyl, tert-butyl, 2-methylhexyl, *n*-pentyl, 1-methylbutyl, 2,2-dimethylbutyl, 2-methylpentyl, 2,2-dimethylpropyl, *n*-hexyl, and the like.

20

The lower alkyl groups include carbon chains of up to 6 carbon atoms. The cycloalkyl groups contemplated by the invention comprise those having 3 to 7 carbon atoms including cyclopentyl and cyclohexyl. They may be substituted with from 1 to 3 groups selected from halogens, nitro, alkyl, and alkoxy.

25

The alkoxy groups contemplated by the invention comprise both straight and branched carbon chains of from 1 to 6 carbon atoms unless otherwise stated. Representative groups are methoxy, ethoxy, propoxy, *i*-propoxy, *t*-butoxy, and hexoxy.

30

The term "halogen" is intended to include fluorine, chlorine, bromine, and iodine.

The term "amine" is intended to include free amino, alkylated amines, and acylated amines.

- 5           The term "subject" includes animals, particularly mammals and more particularly humans.

### **Optical isomers and salts**

- 10           The compounds of the above general formulae all have at least one chiral centre and some have multiple chiral centres depending on their structure. In particular, the compounds of the present invention may exist as diastereoisomers, mixtures of diastereoisomers, or as the mixed or the individual optical enantiomers. The present invention contemplates all such forms of the compounds. The mixtures of
- 15           diastereoisomers are typically obtained as a result of the reactions described more fully below. Individual diastereoisomers may be separated from mixtures of the diastereoisomers by conventional techniques such as column chromatography or repetitive recrystallization. Individual enantiomers may be separated by conventional methods well known in the art such as conversion to a salt with an optically active
- 20           compound, followed by separation by chromatography or recrystallization and reconversion to the non-salt form.

- Where it is appropriate to form a salt, the pharmaceutically acceptable salts include acetate, benzenesulfonate, benzoate, bicarbonate, bitartrate, bromide, calcium
- 25           acetate, camsylate, carbonate, chloride, citrate, dihydrochloride, edetate, edisylate, estolate, esylate, fumarate, gluceptate, gluconate, glutamate, glycolylarsanilate, hexylresorcinate, hydrabamine, hydrobromide, hydrochloride, hydroxynaphthoate, iodide, isethionate, lactate, lactobionate, malate, maleate, mandelate, mesylate, methylbromide, methylnitrate, mucate, napsylate, nitrate, pamoate (embonate),
- 30           pantothenate, phosphate/diphosphate, polygalacturonate, salicylate, stearate, subacetate, succinate, sulfate, tannate, tartrate, theoclate, triethiodide, benzathine,

chloroprocaine, choline, diethanolamine, ethylenediamine, meglumine, procaine, aluminum, calcium, lithium, magnesium, potassium, sodium, and zinc.

Preferred salts are made from strong acids. Such salts include hydrochloride, mesylate, and sulfate.

#### Other non-peptide bombesin antagonists

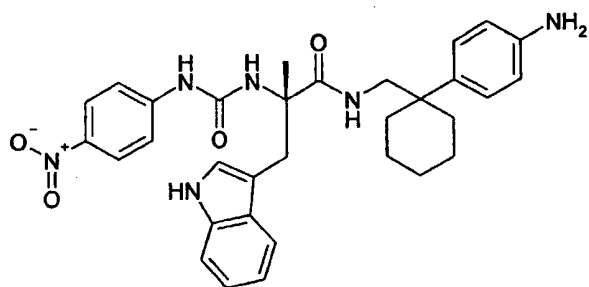
Other non-peptide bombesin antagonists which are believed to be suitable for use in the present invention are described and claimed in the following documents, the contents of which are incorporated herein by reference: WO 00/09115, WO 00/09116, WO 92/07830, JP 07258081 and WO 98/07718.

#### Preparative methods for the compounds of formula (I)

15

Preparation of the compounds of formula (I) is described in WO 98/07718, the disclosure of which is incorporated herein by reference.

Preparation of the closest reported analogues of Compound 3 - (2S)-N-{{[1-(4-aminophenyl)cyclohexyl]methyl}-3-(1H-indol-3-yl)-2-methyl-2-{{(4-nitroanilino)-carbonyl}amino}propanamide are described in Ashwood, V. Brownhill, M. Higginbottom, D. C. Horwell, J. Hughes, R. A. Lewthwaite, A. T. McKnight, R. D. Pinnock, M. C. Pritchard, N. Suman-Chauhan, C. Webb and S. C. Williams. *Bioorg. Med. Chem. Lett.*, 1998, **8**, 2589-2594.; J. E. Eden, M. D. Hall, D. C. Horwell, W. Howson, J. Hughes, R. E. Jordan, R. A. Lewthwaite, K. Martin, A. T. McKnight, J. O'Toole, R. D. Pinnock, M. C. Pritchard, N. Suman-Chauhan and S. C. Williams. *Bioorg. Med. Chem. Lett.*, 1996, **6**, 2617-2622. and in WO98/07718. Compound 3 can be synthesized using methods disclosed in the above publications.



## 5 Preparative methods for compounds of formula (II)

Throughout this application the following abbreviations have the meanings listed below:

10	NEt <sub>3</sub>	triethylamine
	THF	tetrahydrofuran
	HBTU	<i>O</i> -benzotriazol-1-yl- <i>N,N,N',N'</i> -tetramethyluronium hexafluorophosphate
	DIPEA	<i>N,N</i> -diisopropylethylamine
15	DMF	<i>N,N</i> -dimethylformamide
	TEBA	benzyltriethylammonium chloride
	BOC <sub>2</sub> O	di- <i>tert</i> -butyl dicarbonate
	TFA	trifluoroacetic acid
	DMA	<i>N,N</i> -dimethylacetamide
20	EtOAc	ethyl acetate
	MeOH	methanol
	Trp	tryptophan
	Ph	phenyl
	HPLC	high pressure liquid chromatography
25	NP	normal phase
	RP	reverse phase
	DMAP	<i>N,N</i> -dimethyl-4-amino pyridine
	OAc	acetate

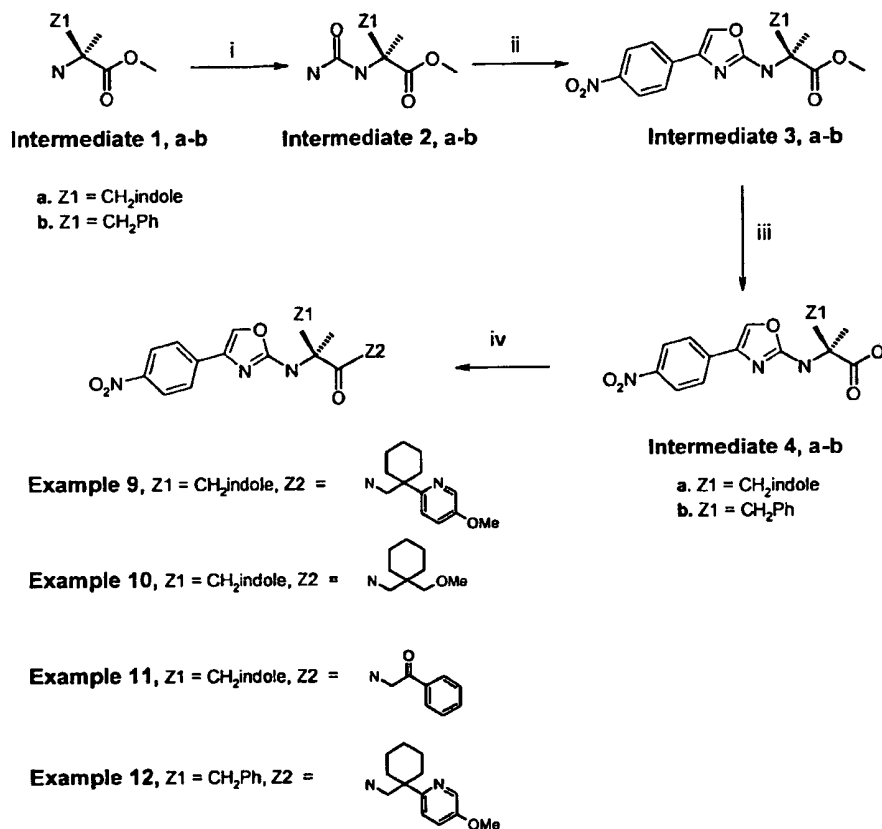
OB                    oestradiol benzoate

The production of compounds of the formula (II) in which X is oxazolyl is shown in Scheme 1 which illustrates the synthesis of the compounds of **Examples 9**  
5    to **12** in four steps via Intermediates **4a** or **4b**. The steps are:

- Formation of the *p*-nitrophenylcarbamate of the methyl ester (Intermediate **1**) and subsequent treatment with aqueous ammonia to give a primary urea (Intermediate **2**).
- 10    • Cyclisation of the primary urea with 2-bromo-1-(4-nitro-phenyl)-ethanone to form an oxazole ring (Intermediate **3**).
- Hydrolysis of the methyl-ester-protecting group gives Intermediates **4a** or **4b**.
- Reaction of Intermediate **4a** or **4b** with the amine **Z2**, using HBTU to form an amide linkage, affords the desired compounds.

15

Scheme 1:



In the above scheme:

- i) a) 4-Nitrophenylchloroformate, NEt<sub>3</sub>, THF b) NH<sub>3</sub> aq.
  - 5 ii) 2-bromo-1-(4-nitro-phenyl)-ethanone in either toluene/dioxan at reflux (3a) or 1,2-dichloroethane at reflux (3b)
  - iii) LiOH, dioxan, H<sub>2</sub>O
  - iv) HBTU, DIPEA, DMF, Z2
- 10 Scheme 2 describes the synthesis of the compounds of **Examples 13 to 15** from **Intermediate 2a**.

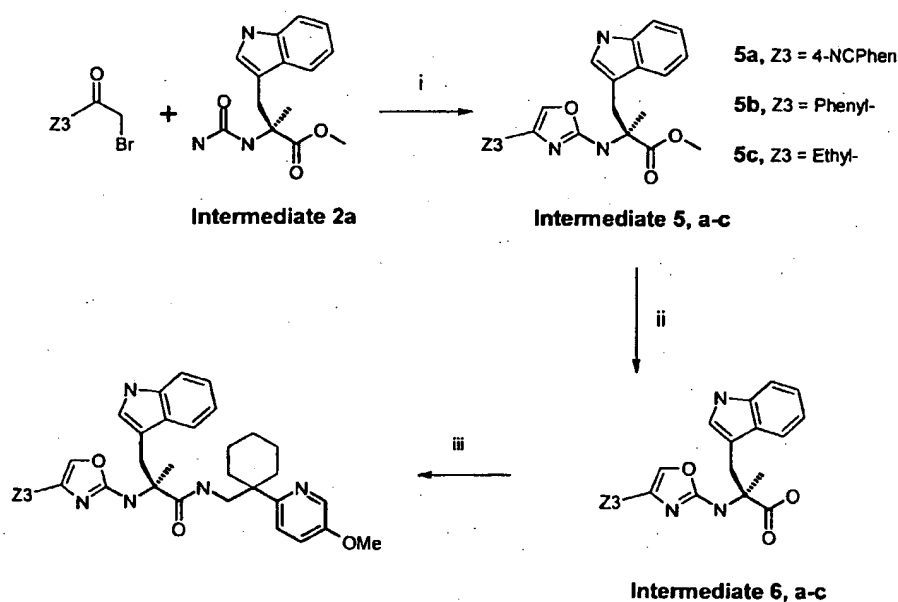
- A primary urea **2a** is cyclised with an appropriate bromomethyl ketone



containing the group Z3 to form an oxazole ring (Intermediate 5).

- Hydrolysis of the methyl ester protecting group of the resulting Intermediate 5a, 5b or 5c gives the Intermediates 6 a-c.
- Reaction of an Intermediate 6a, 6b or 6c with [1-(5-methoxy-2-pyridyl)cyclohexyl]methanamine in the presence of HBTU to form an amide bond affords the desired compounds.

**Scheme 2:**



10

In the above scheme:

- DMF at 30°C
  - LiOH, dioxan, H<sub>2</sub>O
  - HBTU, DIPEA, DMF, [1-(5-methoxy-2-pyridyl)cyclohexyl]methanamine
- 15 (described in WO 98/07718)

Scheme 3 describes a two step synthesis for the compounds of **Examples 16-23**.

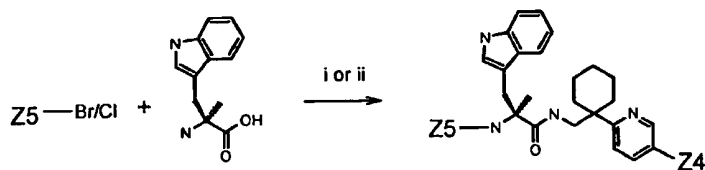
The reactions are preferentially carried out as a "one-pot" process in which:

- An aromatic ring of a compound Z5-Br or Z5-Cl is appended onto the N-terminal of the illustrated amino acid using a copper catalysed reaction.
- Formation of an amide linkage between the resulting acid and [1-(5-methoxy-2-pyridyl)cyclohexyl]methanamine or [1-(2-pyridyl)cyclohexyl]methylamine

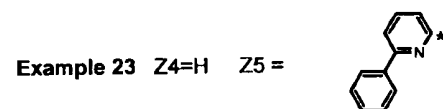
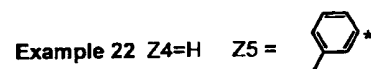
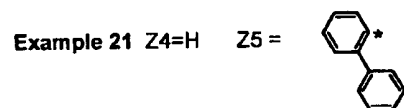
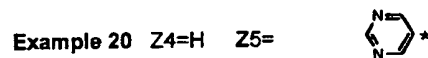
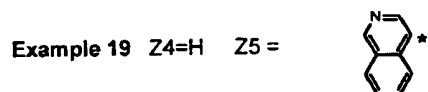
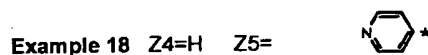
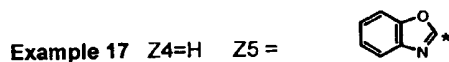
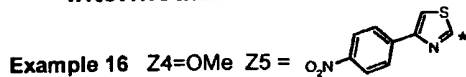
20

in the presence of HBTU affords the desired compounds.

**Scheme 3:**



**Intermediate 7**



5

In the above scheme:

- i) a) 10% CuI, K<sub>2</sub>CO<sub>3</sub>, DMF, 130°C  
 b) HBTU, DIPEA, DMF, and [1-(5-methoxy-2-pyridyl)cyclohexyl]methan-  
 amine (described in WO 98/07718) or [1-(2-pyridyl)cyclohexyl]methylamine  
 (described in WO 98/07718)
- ii) a) 5-10% CuI, K<sub>2</sub>CO<sub>3</sub>, TEBA, Pd(P(*o*-tolyl)<sub>3</sub>)Cl<sub>2</sub>, DMF, 130°C

10

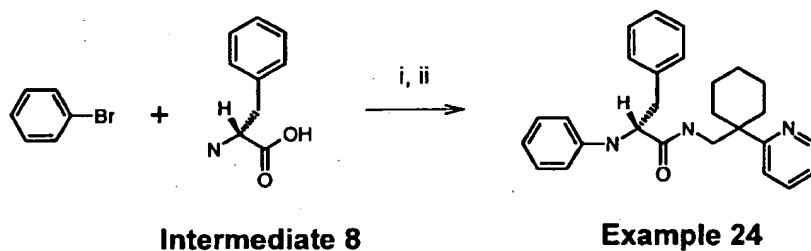
b) HBTU, DIPEA, DMF, and [1-(5-methoxy-2-pyridyl)cyclohexyl]methan-amine (described in WO 98/07718) or [1-(2-pyridyl)cyclohexyl]methylamine (described in WO 98/07718)

5 \* represents the attachment point.

Scheme 4 describes the two step one-pot synthesis of the compound of **Example 24**:

- The aromatic ring is appended onto the N-terminal of the amino acid (**Intermediate 8**) using a copper catalysed reaction and then an in situ HBTU amide bond formation reaction affords the desired compound.

15 **Scheme 4:**



In the above scheme:

- 20 i) 10% CuI, K<sub>2</sub>CO<sub>3</sub>, DMA, 90°C
- ii) HBTU, NEt<sub>3</sub>, DMA, [1-(2-pyridyl)cyclohexyl]methylamine (described in WO 98/07718)

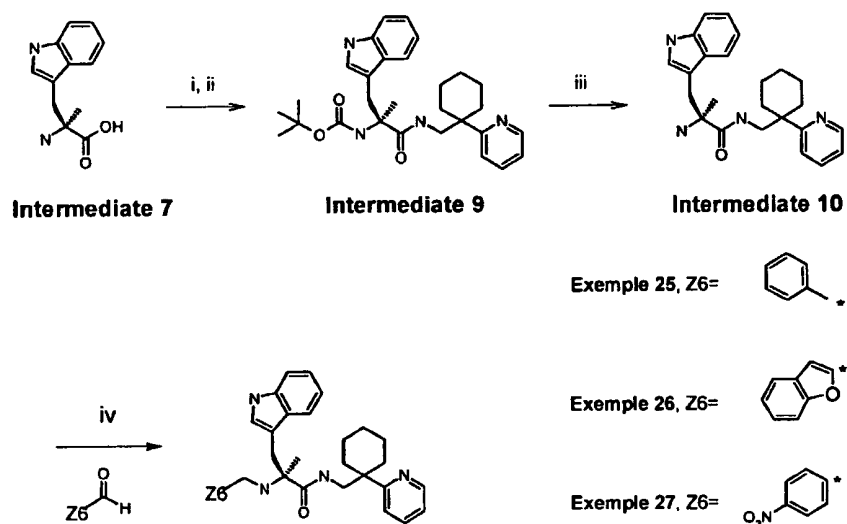
Scheme 5 describes the synthesis of the compounds of **Examples 25 - 27** via **Intermediate 10** by the steps of:

- N-BOC protection of the amino acid (**Intermediate 7**) which provides the groups R<sup>5</sup> and Ar<sup>1</sup>.

- Reaction of the protected amino acid with an amine that provides the groups  $R^1$ ,  $R^2$ ,  $R^4$  and  $R^6$  using HBTU to form an amide linkage, and thereby give the **Intermediate 9**.
  - N-BOC deprotection of the **Intermediate 9** to give **Intermediate 10**.
- 5
- Reductive amination of **Intermediate 10** with the appropriate aldehyde  $Z6CHO$  to give the desired compounds.

Scheme 5:

10



In the above scheme:

- i)  $BOC_2O$ ,  $K_2CO_3$ , dioxane, water
- 15 ii) HBTU, DIPEA, [1-(2-pyridyl)cyclohexyl]methylamine (described in WO 98/07718), DMF
- iii) TFA,  $CH_2Cl_2$
- iv)  $NaBH(OAc)_3$ , 1,2-dichloroethane.

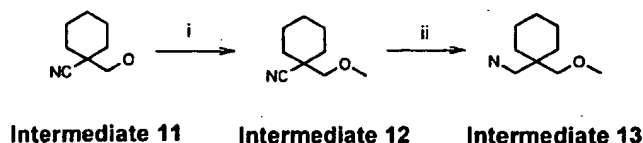
20 \* represents the attachment point.

Scheme 6 describes the synthesis of **Intermediate 13**.

- The alcohol **11** is methylated using sodium hydride.
- The resulting nitrile is reduced using Raney nickel under an atmosphere of hydrogen.

5

Scheme 6:

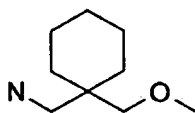


In the above scheme:

- i) NaH, CH<sub>3</sub>I, THF
- 10 ii) Raney nickel, ethanolic ammonia, H<sub>2</sub>, 345 kPa

### Intermediate 13

### C-(1-methoxymethyl-cyclohexyl)-methylaniline



Intermediate 13

15

The above compound was prepared as shown in Scheme 6.

1. Sodium hydride (862mg, 21.5mmol, 60% in oil) was taken up in THF (50ml) under argon at 0°C. To this was added a solution of methyl iodide (1.34ml, 21.6mmol) and 1-hydroxy-cyclohexanecarbonitrile (1.0g, 7.18mmol; see J. Fröhlich *et al.*, 1994) in THF (30ml) dropwise over 45 minutes. Once addition was complete the reaction mixture was stirred at room temperature overnight, and then quenched with *i*-propanol followed by water (100ml). The mixture was then extracted with dichloromethane (2x150ml). The combined organic phases were dried (MgSO<sub>4</sub>) and solvent removed
- 20

under reduced pressure. Residue was purified by chromatography using heptane/ethyl acetate (4:1). Removal of solvent under reduced pressure gave 1-methoxymethyl-cyclohexanecarbonitrile (1.1g, 88%) as a pale yellow oil.

IR (film): 2934, 2861, 2832, 2235, 1476, 1452, 1385, 1211, 1187, 1185, 1126,  
5 1102, 978, 932, 901, 849  $\text{cm}^{-1}$ ;

$^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.13-1.33 (3H, m), 1.57-1.78 (5H, m), 1.94-2.02 (2H, m), 3.36 (1H, s), 3.42 (3H, s);

2. To the 1-methoxymethyl-cyclohexanecarbonitrile (1.1g, 7.2mmol) in ethanolic ammonia (60ml) was added Raney nickel catalyst (0.55g, pre-washed with water and ethanol). Reaction mixture was shaken for 16 hours under hydrogen (345 kPa) at 30°C. The catalyst was filtered off with extreme caution through a bed of Kieselguhr and washed with ethanol. Removal of the solvent under reduced pressure gave **Intermediate 13** (1.12g, 99%) as a yellow oil.

15 MS m/e (ES<sup>+</sup>): 158.2 ( $\text{M}^+ + \text{H}$ , 100%);

IR (film): 2926, 2857, 1572, 1452, 1378, 1316, 1190, 1140, 966  $\text{cm}^{-1}$ ;

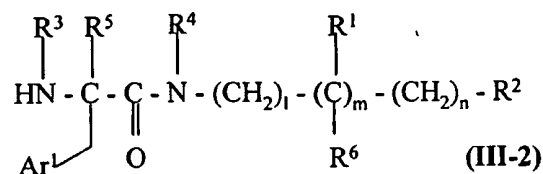
$^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.20-1.60 (12H, m), 2.62 (2H, s), 3.23 (2H, s), 3.32 (3H, s)

## 20 Preparative methods for compounds of formula (III)

Compounds of the formula (III) in which X is  $-\text{CO}-$  can be prepared by condensing an acid of the formula (III-1)

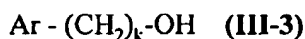


or a derivative thereof with an amine of the formula (III-2)

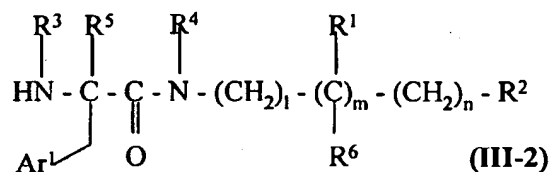


in an aprotic polar solvent in the presence of an appropriate catalyst, the values of the substituents Ar, Ar<sup>1</sup> and R<sup>1</sup> to R<sup>6</sup> and the parameters k to n being as defined above with reference to formula (III), and optionally converting the resulting product to a pharmaceutically acceptable salt. For example, the condensation may be carried out in dimethylformamide using *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (HBTU) and *N,N*-diisopropyl-ethylamine (DIPEA) as catalyst.

Compounds of the formula (III) in which X is -OC(=O)- can be prepared by forming a carbonate from an alcohol of the formula (III-3)



and reacting the carbonate with an amine of the formula (III-2)

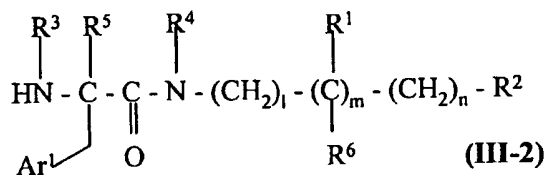


in an aprotic polar solvent in the presence of a base, the values of the substituents Ar, Ar<sup>1</sup> and R<sup>1</sup> to R<sup>6</sup> and the parameters k to n being as defined above with reference to formula (III), and optionally converting the resulting product to a pharmaceutically acceptable salt. For example, the compound of formula (III-3) may be reacted with 4-nitrophenyl chloroformate in dichloromethane using pyridine as catalyst, and the resulting carbonate may be reacted with the amine of formula (III-2) in dimethylformamide using *N,N*-dimethyl-4-amino pyridine as catalyst.

Compounds of the formula (III) in which X is -SO<sub>2</sub>- can be prepared by condensing a sulfonyl chloride of the formula (III-4)

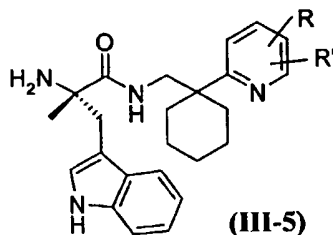


with an amine of the formula (III-2)

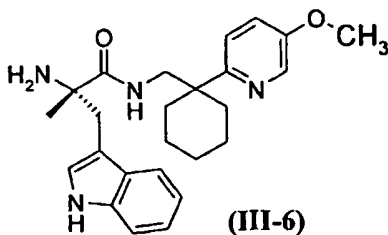


- 5 in an aprotic polar solvent in the presence of a base as catalyst, the values of the substituents Ar, Ar<sup>1</sup> and R<sup>1</sup> to R<sup>6</sup> and the parameters k to n being as defined above with reference to formula (III), and optionally converting the resulting product to a pharmaceutically acceptable salt. For example, the condensation may be carried out in dimethylformamide in the presence of *N,N*-diisopropylethylamine and *N,N*-dimethyl-  
 10 4-aminopyridine.

In the above methods, the amine of formula (III-2) is preferably a chiral amine of formula (III-5)



- 15 wherein the pyridine ring is optionally substituted by with 1 or 2 substituents R and R' selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy, - CF<sub>3</sub>, - (CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, wherein R<sup>7</sup> and R<sup>8</sup> can form a ring of between 5 to 7 atoms, which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>7</sup> and R<sup>8</sup> can be independently selected from hydrogen or cyclic alkyl of from 1 to 5 carbon atoms, methoxy being a  
 20 particularly preferred substituent, as in the chiral amine (III-6):





**B) Peptide bombesin receptor antagonists**

Bombesin antagonists which are peptides and which are believed to be suitable for use in the present invention are described in the following documents, the contents of which are incorporated herein by reference:

Publication number	Publication number
WO 97/09347	EP 0835662
US 5650395	US 5439884
WO 96/28214	WO 95/00542
EP 0737691	US 5620955
US 5767236	WO 92/02545
WO 91/04040	EP 0468497
EP 0309297	CA 2030212
EP 0438519	WO 92/20707
EP 0559756	WO 93/16105
WO 89/02897	US 4943561
WO 90/03980	US 5019647
WO 91/02746	US 5028692
WO 92/09626	US 5047502
WO 92/20363	WO 94/02018
WO 94/02163	WO 88/07551
WO 94/21674	WO 89/09232
WO 96/17617	EP 0315367
US 5084555	EP 0345990
US 5162497	US 5068222
US 5244883	US 5620959
US 5723578	UK 2231051
US 5750646	EP 0339193
US 5877277	WO 90/01037
US 5985834	WO 91/06563
EP 0428700	EP 0402852

**Pharmaceutical compositions**

- 10 For preparing pharmaceutical compositions from the compounds of this invention, inert, pharmaceutically acceptable carriers can be either solid or liquid. Solid form preparations include powders, tablets, dispersible granules, capsules, sachets, and suppositories.

A solid carrier can be one or more substances which may also act as diluents, flavouring agents, solubilizers, lubricants, suspending agents, binders, or tablet disintegrating agents; it can also be an encapsulating material. In powders, the carrier is a finely divided solid which is in a mixture with the finely divided active component. In tablets, the active component is mixed with the carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired. The powders and tablets preferably contain 5% to about 70% of the active component. Suitable carriers are magnesium carbonate, magnesium stearate, talc, lactose, sugar, pectin, dextrin, starch, tragacanth, methyl cellulose, sodium carboxymethyl cellulose, a low-melting wax, cocoa butter, and the like.

Liquid form preparations include solutions, suspensions, and emulsions. Sterile water or water-propylene glycol solutions of the active compounds may be mentioned as an example of liquid preparations suitable for parenteral administration. Liquid preparations can also be formulated in solution in aqueous polyethylene glycol solution. Aqueous solutions for oral administration can be prepared by dissolving the active component in water and adding suitable colorants, flavouring agents, stabilizers, and thickening agents as desired. Aqueous suspensions for oral use can be made by dispersing the finely divided active component in water together with a viscous material such as natural synthetic gums, resins, methyl cellulose, sodium carboxymethyl cellulose, and other suspending agents known to the pharmaceutical formulation art.

Preferably the pharmaceutical preparation is in unit dosage form. In such form, the preparation is divided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of the preparation, for example, packeted tablets, capsules, and powders in vials or ampoules. The unit dosage form can also be a capsule, sachet, or tablet itself, or it can be the appropriate number of any of these packaged forms.

For preparing suppository preparations, a low-melting wax such as a mixture of fatty acid glycerides and cocoa butter is first melted and the active ingredient is dispersed therein by, for example, stirring. The molten homogeneous mixture is then poured into convenient sized moulds and allowed to cool and solidify.

5

Compositions that are adapted for oral administration to humans are preferred, especially such compositions in unit dosage form.

### Combination therapy

10

Without wishing to be bound by any particular theory or teaching, the inventors believe that bombesin receptor antagonists could be used as part of a medicament in combination with one or more vasodilator, hormone therapy or neurotransmitter modulator. Such products are used or tested in the treatment of sexual dysfunction.

15

Vasodilators for the treatment of sexual dysfunctions of organic (rather than psychogenic) origin, act at the penis, clitoris or vagina level on local blood flow or lubricant secretions. Vasodilators useful for the treatment of sexual dysfunction include alprostadil or phentolamine, NO (nitric oxide) enhancers such as L-arginine, and PDE5 inhibitors such as sildenafil or a pharmaceutically acceptable salt thereof (*Scrip's Complete Guide to Women's Healthcare*, p.194-205, 2000)(Sachs B.D., 2000, Benet and Melman, 1995), VIP (Vaso Intestinal Peptide) enhancers (*Scrip's Complete Guide to Women's Healthcare*, p.194-205, 2000) or angiotensin-2 receptor antagonists such as losartan (American Heart Association meeting, New Orleans, 2000).

20

25

Hormone therapies useful in the treatment of sexual dysfunction of organic and psychogenic nature include modulators of steroid hormones, steroid hormones or hormone product (including synthetic hormones) including oestrogen (*Scrip's Complete Guide to Women's Healthcare*, p.194-205, 2000), or androgens such as testosterone (*Scrip's Complete Guide to Women's Healthcare*, p.194-205, 2000, Sachs

30

B.D., 2000), which act in areas of the CNS associated with sexual desire and sexual arousal (Wilson CA., 1993).

Neurotransmitter modulators useful in the treatment of both psychogenic and organic sexual dysfunction include neurotransmitter agonists and antagonists such as catecholamine agonists such as the D<sub>2</sub> agonist quinolorane, 5HT<sub>2</sub> antagonists such as ritanserin, monoamine synthesis modifiers such as treatments that reduce endogenous 5HT activity, including inhibition of 5HT synthesis using para-chlorophenylalanine, monoamine metabolism or uptake modifiers that inhibit catecholamine metabolism or reuptake, such as tricyclic antidepressants, e.g. imipramine (Wilson CA., 1993).

The use of this combination therapy includes the preparation of therapies that would allow administration of both components of the medicament, i.e. bombesin receptor antagonists and a vasodilator, hormone therapy medicament or neurotransmitter modulator medicament in a single dose. A preferred formulation would allow oral administration. However, administration by suppository, cream, transdermal patch or injection is also part of this invention. Alternatively the inventors envisage formulations that allow administration of the bombesin receptor antagonist via a separate route to that of the vasodilator, hormone therapy medicament or neurotransmitter modulator medicament. Such routes could include for example oral administration of the bombesin receptor antagonist and transdermal patch application of the vasodilator. Thus there may be provided a kit in which unit doses of bombesin receptor antagonist occur in association with unit doses of the vasodilator, hormone therapy medicament or neurotransmitter modulator medicament. For example, in the case of a kit where bombesin receptor antagonist is formulated as a tablet capsule or other unit dosage form for oral administration and the vasodilator is provided as a transdermal patch, the two dosage forms could be provided in the form of a two-row tear-off strip in which compartments containing the tablets, etc. occur above compartments containing the transdermal patches. Other forms of packaging in which the two dosage forms are spatially associated so as to make it easy for patients to take them together and to be reminded when they have done so will readily occur to

those skilled in the art. The kit will also contain instructions as to when and how the individual components of the kit should be administered.

More generally, the invention provides a pharmaceutical combination (for  
5 simultaneous, separate or sequential administration) of a bombesin receptor antagonist and one or more materials selected from (1) to (34) below:

(1) One or more naturally occurring or synthetic prostaglandins or esters thereof. Suitable prostaglandins for use herein include compounds such as alprostadil,  
10 prostaglandin E<sub>1</sub>, prostaglandin E<sub>0</sub>, 13, 14 - dihydroprostaglandin E<sub>1</sub>, prostaglandin E<sub>2</sub>, eprostamol, natural synthetic and semi-synthetic prostaglandins and derivatives thereof including those described in WO-00033825 and/or US 6,037,346 issued on 14th March 2000 all incorporated herein by reference, PGE<sub>0</sub>, PGE<sub>1</sub>, PGA<sub>1</sub>, PGB<sub>1</sub>, PGF<sub>1</sub>  $\alpha$ , 19-hydroxy PGA<sub>1</sub>, 19-hydroxy - PGB<sub>1</sub>, PGE<sub>2</sub>, PGB<sub>2</sub>, 19-hydroxy-PGA<sub>2</sub>, 19-hydroxy-  
15 PGB<sub>2</sub>, PGE<sub>3</sub> $\alpha$ , carboprost, tromethamine, dinoprost, dinoprostone, iloprost, gemeprost, metenoprost, sulprostone, tiaprost and moxislylate.

(2) One or more  $\alpha$  - adrenergic receptor antagonist compounds also known as  $\alpha$  - adrenoceptor antagonists or  $\alpha$ -receptor antagonists or  $\alpha$ -blockers. Suitable  
20 compounds for use herein include: the  $\alpha$ -adrenergic receptor blockers as described in PCT application WO99/30697 published on 14th June 1998, the disclosure of which relating to  $\alpha$ -adrenergic receptors incorporated herein by reference and include, selective  $\alpha_1$ -adrenoceptor or  $\alpha_2$ -adrenoceptor blockers and non-selective adrenoceptor blockers, Suitable  $\alpha_1$ -adrenoceptor blockers include: phentolamine, phentolamine  
25 mesylate, trazodone, alfuzosin, indoramin, naftopidil, tamsulosin, dapiprazole, phenoxybenzamine, idazoxan, efarzan, yohimbine, rauwolfia alkaloids, Recordati 15/2739, SNAP 1069, SNAP 5089, RS17053, SL 89.0591, doxazosin, terazosin, abanoquil and prazosin;  $\alpha_2$ -blocker blockers from US 6,037,346 [14th March 2000] dibenamine, tolazoline, trimazosin and dibenamine;  $\alpha$ -adrenergic receptor antagonists  
30 as described in US patents: 4,188,390; 4,026,894; 3,511,836; 4,315,007; 3,527,761; 3,997,666; 2,503,059; 4,703,063; 3,381,009; 4,252,721 and 2,599,000 each of which

is incorporated herein by reference;  $\alpha_2$ -Adrenoceptor blockers include: clonidine, papaverine, papaverine hydrochloride, optionally in the presence of a cardiotonic agent such as pirxamine.

- 5 (3) One or more NO-donor (NO-agonist) compounds. Suitable NO-donor compounds for use herein include organic nitrates, such as mono- di or tri-nitrates or organic nitrate esters including glyceryl trinitrate (also known as nitroglycerin), isosorbide 5-mononitrate, isosorbide dinitrate, pentaerythritol tetranitrate, erythrityl tetranitrate, sodium nitroprusside (SNP), 3-morpholinosydnonimine, molsidomine, S-  
10 nitroso- N-acetyl penicillamine (SNAP) S-nitroso-N-glutathione (SNO-GLU), N-hydroxy - L-arginine, amylnitrate, linsidomine, linsidomine hydrochloride, (SIN-1) S-nitroso - N-cysteine, diazenium diolates,(NONOates), 1,5-pentanedinitrate, L-arginine, ginseng, zizphi fructus, molsidomine, Re - 2047, nitrosylated maxisylte derivatives such as NMI-678-11 and NMI-937 as described in published PCT  
15 application WO 0012075 ; and/or

- (4) One or more potassium channel openers or modulators. Suitable potassium channel openers/modulators for use herein include nicorandil, cromokalim, levromakalim (lemakalim), pinacidil, diazoxide, minoxidil, charybdotoxin,  
20 glyburide, 4-aminopyridine, BaCl<sub>2</sub>.

- (5) One or more dopaminergic agents, preferably apomorphine or a selective D<sub>2</sub>, D<sub>3</sub> or D<sub>2</sub>/D<sub>3</sub>agonist such as, pramipexole and ropirinol (as claimed in WO-0023056),PNU95666 (as claimed in WO-0040226).

25

- (6) One or more vasodilator agents. Suitable vasodilator agents for use herein include nimodepine, pinacidil, cyclandelate, isoxsuprine, chlorpromazine, halo peridol, Rec 15/2739, trazodone.

- 30 (7) One or more thromboxane A<sub>2</sub> agonists.

- (8) One or more CNS active agents.

(9) One or more ergot alkaloids. Suitable ergot alkaloids are described in US patent 6,037,346 issued on 14th March 2000 and include acetergamine, brazergoline, bromerguride, cianergoline, delorgotril, disulergine, ergonovine maleate, ergotamine  
5 tartrate, etisulergine, lergotril, lysergide, mesulergine, metergoline, metergotamine, nicergoline, pergolide, propisergide, proterguride, terguride.

(10) One or more compounds which modulate the action of natriuretic factors in particular atrial natriuretic factor (also known as atrial natriuretic peptide), B type and  
10 C type natriuretic factors.

(11) One or more angiotensin receptor antagonists such as losartan.

(12) One or more substrates for NO-synthase, such as L-arginine.  
15

(13) One or more calcium channel blockers such as amlodipine.

(14) One or more cholesterol lowering agents such as statins (e.g. atorvastatin/  
Lipitor- trade mark) and fibrates.  
20

(15) One or more antiplatelet and antithrombotic agents, e.g. tPA, uPA, warfarin, hirudin and other thrombin inhibitors, heparin, thromboplastin activating factor inhibitors.

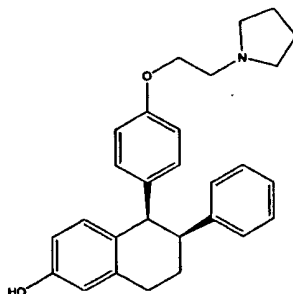
(16) One or more insulin sensitising agents such as triglitazone (rezulin) and hypoglycaemic agents such as glipizide.  
25

(17) L-DOPA or carbidopa.

(18) One or more acetylcholinesterase inhibitors such as donepezil (Aricept).  
30

(19) One or more steroidal or non-steroidal anti-inflammatory agents.

- (20) One or more estrogen receptor modulators (SERM) and/or estrogen agonists and/or estrogen antagonists, preferably raloxifene or lasofoxifene, (-)-cis-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol and pharmaceutically acceptable salts thereof (compound A below) the preparation of which is detailed in WO 96/21656.



Compound A

- (21) One or more PDE inhibitors, more particularly a PDE 2, 5, 7 or 8 inhibitor (for oral or local administration), preferably PDE2 or PDE5 inhibitor and most preferably a PDE5 inhibitor (see hereinafter), said inhibitors preferably having an IC<sub>50</sub> against the respective enzyme of less than 100nM; and PDE 3 , 4 inhibitor for local administration (e.g. intracavernosal injection).
- (22) In the case where the combination is for the treatment or prophylaxis of female sexual dysfunction, one or more of an NPY (neuropeptide Y) inhibitor, more particularly NPY1 or NPY5 inhibitor, preferably NPY1 inhibitor. Preferably said NPY inhibitors (including NPYY1 and NPYY5) have an IC<sub>50</sub> of less than 100 nM, more preferably less than 50 nM.
- (23) One or more of a neutral endopeptidase (NEP) inhibitor preferably having an IC<sub>50</sub> for NEP of less than 100nM. Preferably the NEP inhibitor is selective for NEP and has a selectivity over the endothelin converitin enzyme (ECE) and angiotensin converting enzyme (ACE) of greater than 100. However, mixed/dual NEP/ECE and NEP/ACE inhibitors (such as ompatrilat) are still within the scope of the invention.



- (24) One or more of vasoactive intestinal protein (VIP), VIP mimetic, VIP analogue, more particularly acting through one or more of the VIP receptor subtypes VPAC1, VPAC or PACAP (pituitary adenylate cyclase activating peptide), one or more of a VIP receptor agonist or a VIP analogue (eg Ro-125-1553) or a VIP  
5 fragment, one or more of a  $\alpha$ -adrenoceptor antagonist with VIP combination (eg Invicorp, Aviptadil).
- (25) One or more of a melanocortin receptor agonist or modulator or melanocortin enhancer, such as melanotan II, PT-14, PT-141 or compounds claimed in WO-  
10 09964002, WO-00074679, WO-09955679, WO-00105401, WO-00058361, WO-00114879, WO-00113112, WO-09954358.
- (26) One or more of a serotonin receptor agonist, antagonist or modulator, more particularly agonists, antagonists or modulators for 5HT1A (including VML 670),  
15 5HT2A, 5HT2C, 5HT3 and/or 5HT6 receptors, including those described in WO-09902159, WO-00002550 and/or WO-00028993..
- (27) One or more of a testosterone replacement agent (including dehydroandrostendione), testosterone (Tostrelle), dihydrotestosterone or a  
20 testosterone implant.
- (28) One or more of estrogen, estrogen and medroxyprogesterone or medroxyprogesterone acetate (MPA) (i.e. as a combination), or estrogen and methyl testosterone hormone replacement therapy agent (e.g. HRT especially Premarin,  
25 Cenestin, Oestrofeminal, Equin, Estrace, Estrofem, Elleste Solo, Estring, Estraderm TTS, Estraderm Matrix, Dermestril, Premphase, Preempro, Prempak, Premique, Estratest, Estratest HS, Tibolone).
- (29) One or more of a modulator of transporters for noradrenaline, dopamine  
30 and/or serotonin, such as bupropion, GW-320659.
- (30) One or more of a purinergic receptor agonist and/or modulator.

(31) One or more of a neurokinin (NK) receptor antagonist, including those described in WO-09964008.

5 (32) One or more of an opioid receptor agonist, antagonist or modulator, preferably agonists for the ORL-1 receptor.

(33) One or more of an agonist or modulator for oxytocin/vasopressin receptors, preferably a selective oxytocin agonist or modulator.

10

(34) One or more modulators of cannabinoid receptors.

**Auxiliary Agent PDE5 inhibitor (I:PDE5) :**

**15 PDE5 Inhibitors**

Suitable PDE5i's for use in the pharmaceutical combinations according to the present invention are the cGMP PDE5i's hereinafter detailed. Particularly preferred for use herein are potent and selective cGMP PDE5i's. Suitable cGMP PDE5

20 inhibitors for the use according to the present invention include:

- pyrazolo [4,3-d]pyrimidin-7-ones disclosed in EP-A-0463756;
- pyrazolo [4,3-d]pyrimidin-7-ones disclosed in EP-A-0526004;
- pyrazolo [4,3-d]pyrimidin-7-ones disclosed in published international patent application WO 93/06104;
- 25 • isomeric pyrazolo [3,4-d]pyrimidin-4-ones disclosed in published international patent application WO 93/07149;
- quinazolin-4-ones disclosed in published international patent application WO 93/12095;
- 30 • pyrido [3,2-d]pyrimidin-4-ones disclosed in published international patent application WO 94/05661;

- purin-6-ones disclosed in published international patent application WO 94/00453;
- pyrazolo [4,3-d]pyrimidin-7-ones disclosed in published international patent application WO 98/49166;
- 5 • pyrazolo [4,3-d]pyrimidin-7-ones disclosed in published international patent application WO 99/54333;
- pyrazolo [4,3-d]pyrimidin-4-ones disclosed in EP-A-0995751;
- pyrazolo [4,3-d]pyrimidin-7-ones disclosed in published international patent application WO 00/24745;
- 10 • pyrazolo [4,3-d]pyrimidin-4-ones disclosed in EP-A-0995750;
- the compounds disclosed in published international application WO95/19978;
- the compounds disclosed in published international application WO 99/24433 and
- the compounds disclosed in published international application WO 93/07124.

15

It is to be understood that the contents of the above published patent applications, and in particular the general formulae and exemplified compounds therein are incorporated herein in their entirety by reference thereto.

- 20 Preferred type V phosphodiesterase inhibitors for the use according to the present invention include:

5-[2-ethoxy-5-(4-methyl-1-piperazinylsulphonyl)phenyl]-1-methyl-3-n-propyl-1,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (sildenafil) also known as 1-  
25 [[3-(6,7-dihydro-1-methyl-7-oxo-3-propyl-1H-pyrazolo[4,3-d]pyrimidin-5-yl)-4-ethoxyphenyl]sulphonyl]-4-methylpiperazine (see EP-A-0463756);

5-(2-ethoxy-5-morpholinoacetylphenyl)-1-methyl-3-n-propyl-1,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see EP-A-0526004);

3-ethyl-5-[5-(4-ethylpiperazin-1-ylsulphonyl)-2-n-propoxyphenyl]-2-(pyridin-  
30 2-yl)methyl-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO98/49166);

3-ethyl-5-[5-(4-ethylpiperazin-1-ylsulphonyl)-2-(2-methoxyethoxy)pyridin-3-yl]-2-(pyridin-2-yl)methyl-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO99/54333 );

(+)-3-ethyl-5-[5-(4-ethylpiperazin-1-ylsulphonyl)-2-(2-methoxy-1(R)-methylethoxy)pyridin-3-yl]-2-methyl-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one, also known as 3-ethyl-5-{5-[4-ethylpiperazin-1-ylsulphonyl]-2-[(1R)-2-methoxy-1-methylethyl]oxy}pyridin-3-yl}-2-methyl-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO99/54333);

5-[2-ethoxy-5-(4-ethylpiperazin-1-ylsulphonyl)pyridin-3-yl]-3-ethyl-2-[2-methoxyethyl]-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one, also known as 1-{6-ethoxy-5-[3-ethyl-6,7-dihydro-2-(2-methoxyethyl)-7-oxo-2H-pyrazolo[4,3-d]pyrimidin-5-yl]-3-pyridylsulphonyl}-4-ethylpiperazine (see WO 01/27113, Example 8);

5-[2-*iso*-Butoxy-5-(4-ethylpiperazin-1-ylsulphonyl)pyridin-3-yl]-3-ethyl-2-(1-methylpiperidin-4-yl)-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO 01/27113, Example 15);

5-[2-Ethoxy-5-(4-ethylpiperazin-1-ylsulphonyl)pyridin-3-yl]-3-ethyl-2-phenyl-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO 01/27113, Example 66);

5-(5-Acetyl-2-propoxy-3-pyridinyl)-3-ethyl-2-(1-isopropyl-3-azetidiny)-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO 01/27112, Example 124);

5-(5-Acetyl-2-butoxy-3-pyridinyl)-3-ethyl-2-(1-ethyl-3-azetidiny)-2,6-dihydro-7H-pyrazolo[4,3-d]pyrimidin-7-one (see WO 01/27112, Example 132);

(6R,12aR)-2,3,6,7,12,12a-hexahydro-2-methyl-6-(3,4-methylenedioxyphenyl)-pyrazino[2',1':6,1]pyrido[3,4-b]indole-1,4-dione (IC-351), i.e. the compound of examples 78 and 95 of published international application WO95/19978, as well as the compound of examples 1, 3, 7 and 8;

2-[2-ethoxy-5-(4-ethylpiperazin-1-yl-1-sulphonyl)-phenyl]-5-methyl-7-propyl-3H-imidazo[5,1-f][1,2,4]triazin-4-one (vardenafil) also known as 1-[[3-(3,4-dihydro-5-methyl-4-oxo-7-propylimidazo[5,1-f]-as-triazin-2-yl)-4-ethoxyphenyl]sulphonyl]-4-ethylpiperazine, i.e. the compound of examples 20, 19, 337 and 336 of published international application WO99/24433; and

the compound of example 11 of published international application WO93/07124 (EISAI); and

compounds 3 and 14 from Rotella D P, *J. Med. Chem.*, 2000, 43, 1257.

5 Still other type cGMP PDE5 inhibitors useful in conjunction with the present invention include:

4-bromo-5-(pyridylmethylamino)-6-[3-(4-chlorophenyl)-propoxy]-3(2H)pyridazinone;

10 1-[4-[(1,3-benzodioxol-5-ylmethyl)amiono]-6-chloro-2-quinazoliny]-4-piperidine-carboxylic acid, monosodium salt;

(+)-cis-5,6a,7,9,9a-hexahydro-2-[4-(trifluoromethyl)-phenylmethyl-5-methyl-cyclopent-4,5]imidazo[2,1-b]purin-4(3H)one;

furazlocillin;

15 cis-2-hexyl-5-methyl-3,4,5,6a,7,8,9,9a- octahydrocyclopent[4,5]-imidazo[2,1-b]purin-4-one; 3-acetyl-1-(2-chlorobenzyl)-2-propylindole-6- carboxylate; 3-acetyl-1-(2-chlorobenzyl)-2-propylindole-6-carboxylate;

4-bromo-5-(3-pyridylmethylamino)-6-(3-(4-chlorophenyl) propoxy)-3-(2H)pyridazinone;

20 I-methyl-5(5-morpholinoacetyl-2-n-propoxyphenyl)-3-n-propyl-1,6-dihydro-7H-pyrazolo(4,3-d)pyrimidin-7-one;

1-[4-[(1,3-benzodioxol-5-ylmethyl)arnino]-6-chloro-2- quinazoliny]-4-piperidinecarboxylic acid, monosodium salt;

Pharmaprojects No. 4516 (Glaxo Wellcome);

Pharmaprojects No. 5051 (Bayer);

25 Pharmaprojects No. 5064 (Kyowa Hakko; see WO 96/26940);

Pharmaprojects No. 5069 (Schering Plough);

GF-196960 (Glaxo Wellcome);

E-8010 and E-4010 (Eisai); Bay-38-3045 & 38-9456 (Bayer); and

Sch-51866.

30

The suitability of any particular cGMP PDE5 inhibitor can be readily determined by evaluation of its potency and selectivity using literature methods

followed by evaluation of its toxicity, absorption, metabolism, pharmacokinetics, etc in accordance with standard pharmaceutical practice.

Preferably, the cGMP PDE5 inhibitors have an  $IC_{50}$  at less than 100  
5 nanomolar, more preferably, at less than 50 nanomolar, more preferably still at less than 10 nanomolar.  $IC_{50}$  values for the cGMP PDE5 inhibitors may be determined using the PDE5 assay in the Test Methods Section hereinafter.

Preferably the cGMP PDE5 inhibitors used in the pharmaceutical  
10 combinations according to the present invention are selective for the PDE5 enzyme. Preferably they are selective over PDE3, more preferably over PDE3 and PDE4. Preferably, the cGMP PDE5 inhibitors of the invention have a selectivity ratio greater than 100 more preferably greater than 300, over PDE3 and more preferably over PDE3 and PDE4. Selectivity ratios may readily be determined by the skilled person.  
15  $IC_{50}$  values for the PDE3 and PDE4 enzyme may be determined using established literature methodology, see S A Ballard *et al* (1998) and as detailed hereinafter.

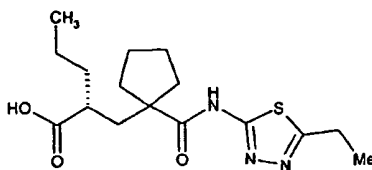
**Auxiliary Agent : NEP inhibitor (I:NEP)**

20 NEP EC3.4.24.11 (*FEBS Lett.*, 229(1), 206-210 (1988)), also known as enkephalinase or neprilysin, is a zinc-dependent neutral endopeptidase. This enzyme is involved in the breakdown of several bioactive oligopeptides, cleaving peptide bonds on the amino side of hydrophobic amino acid residues (Reviewed in Turner et al., 1997). The key neuronally released bioactive agents or neuropeptides metabolised  
25 by NEP include natriuretic peptides such as atrial natriuretic peptides (ANP) as well as brain natriuretic peptide and C-type natriuretic peptide, bombesin, bradykinin, calcitonin gene-related peptide, endothelins, enkephalins, neurotensin, substance P and vasoactive intestinal peptide. Some of these peptides have potent vasodilatory and neurohormone functions, diuretic and natriuretic activity or mediate behaviour  
30 effects. Background teachings on NEP have been presented by Victor A. McKusick et al on <http://www3.ncbi.nlm.nih.gov/Omim/searchomim.htm>. The following information concerning NEP has been extracted from that source.

“Common acute lymphocytic leukemia antigen is an important cell surface marker in the diagnosis of human acute lymphocytic leukemia (ALL). It is present on leukemic cells of pre-B phenotype, which represent 85% of cases of ALL. CALLA is not restricted to leukemic cells, however, and is found on a variety of normal tissues. CALLA is a glycoprotein that is particularly abundant in kidney, where it is present on the brush border of proximal tubules and on glomerular epithelium. Letarte et al. (1988) cloned a cDNA coding for CALLA and showed that the amino acid sequence deduced from the cDNA sequence is identical to that of human membrane-associated neutral endopeptidase (NEP; EC 3.4.24.11 ), also known as enkephalinase. NEP cleaves peptides at the amino side of hydrophobic residues and inactivates several peptide hormones including glucagon, enkephalins, substance P, neurotensin, oxytocin, and bradykinin. By cDNA transfection analysis, Shipp et al. (1989) confirmed that CALLA is a functional neutral endopeptidase of the type that has previously been called enkephalinase. Barker et al. (1989) demonstrated that the CALLA gene, which encodes a 100-kD type II transmembrane glycoprotein, exists in a single copy of greater than 45 kb which is not rearranged in malignancies expressing cell surface CALLA. The gene was located to human chromosome 3 by study of somatic cell hybrids and in situ hybridization regionalized the location to 3q21-q27. Tran-Paterson et al. (1989) also assigned the gene to chromosome 3 by Southern blot analysis of DNA from human-rodent somatic cell hybrids. D'Adamio et al. (1989) demonstrated that the CALLA gene spans more than 80 kb and is composed of 24 exons.”

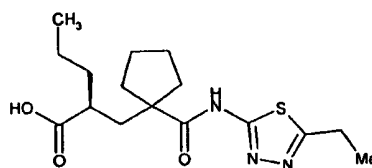
Preferred for NEPi's for use as auxiliary agents in combination with bombesin receptor antagonists according to the present invention are:

(2*R*)-2-[(1-[[[(5-ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl}cyclopentyl)methyl]pentanoic acid



and

**(2S)-2-[(1-[(5-Ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl)cyclopentyl]-methyl]pentanoic acid**



5

The title product from stage c) below (824mg) was further purified by HPLC using an AD column and using hexane:*iso*-propanol:trifluoroacetic acid (85:15:0.2) as elutant to give (2R)-2-[(1-[(5-ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl)-cyclopentyl) methyl]pentanoic acid as a white foam, 400mg, 99.5% ee,

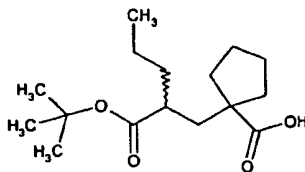
10  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400MHz)  $\delta$ : 0.90 (t, 3H), 1.36 (m, 6H), 1.50-1.80 (m, 9H), 2.19 (m, 1H), 2.30 (m, 1H), 2.44 (m, 1H), 2.60 (m, 1H), 2.98 (q, 2H), 12.10-12.30 (bs, 1H), LRMS : m/z 338 (MH $^+$ ),  $[\alpha]_D = -9.0^\circ$  (c = 0.1, methanol), and (2S)-2-[(1-[(5-ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl)cyclopentyl)-methyl]pentanoic acid as a white foam, 386mg, 99% ee,  $^1\text{H}$  NMR ( $\text{CDCl}_3$ , 400MHz)  $\delta$ : 0.90 (t, 3H), 1.38 (m, 6H), 1.50-1.79 (m, 9H), 2.19 (m, 1H), 2.30 (m, 1H), 2.44 (m, 1H), 2.60 (m, 1H), 2.98 (q, 2H), 12.10-12.27 (bs, 1H); LRMS: m/z 338 (MH $^+$ ); and  $[\alpha]_D = +3.8^\circ$  (c = 0.1, methanol)

15

### Preparation of Starting Materials

20

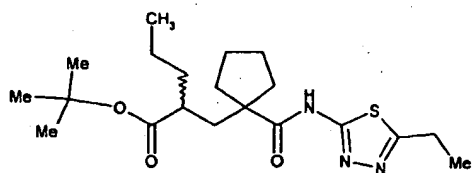
#### a) 1-[2-(*tert*-Butoxycarbonyl)-4-pentyl]-cyclopentane carboxylic acid





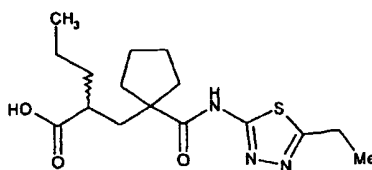
A mixture of 1-[2-(*tert*-butoxycarbonyl)-4-pentenyl]-cyclopentane carboxylic acid (EP 274234) (23g, 81.5mmol) and 10% palladium on charcoal (2g) in dry ethanol (200ml) was hydrogenated at 30psi and room temperature for 18 hours. The reaction mixture was filtered through Arbocel®, and the filtrate evaporated under reduced pressure to give a yellow oil. The crude product was purified by column chromatography on silica gel, using ethyl acetate:pentane (40:60) as the eluant, to provide the desired product as a clear oil, 21g, 91%; <sup>1</sup>H NMR (CDCl<sub>3</sub>, 0.86 (t, 3H), 1.22-1.58 (m, 15H), 1.64 (m, 4H), 1.78 (dd, 1H), 2.00-2.18 (m, 3H), 2.24 (m, 1H); LRMS: m/z 283 (M-H)

b) tert-Butyl 2-[(1-[(5-ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl]-cyclopentyl)methyl]pentanoate.



1-(3-Dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (0.21mmol), 1-hydroxybenzotriazole hydrate (0.2mmol), N-methylmorpholine (0.31mmol) and 2-amino-5-ethyl-1,3,4-thiadiazole (0.22mmol) were added to a solution of the product from stage a) above (150mg, 0.53mmol) in N,N-dimethylformamide (3ml), and the reaction stirred at 90°C for 18 hours. The cooled solution was diluted with ethyl acetate (90ml), washed with water (3x25ml), and brine (25ml), then dried (MgSO<sub>4</sub>) and evaporated under reduced pressure. The crude product was purified by chromatography on silica gel, using ethyl acetate:pentane (30:70) as the eluant to afford the title compound, 92%; <sup>1</sup>H NMR (CDCl<sub>3</sub>, 300MHz) δ: 0.82 (t, 3H), 1.20-1.80 (m, 22H), 1.84 (m, 1H), 2.20 (m, 4H), 3.04 (q, 2H), 9.10 (bs, 1H); LRMS: m/z 396.2 (MH<sup>+</sup>).

c) 2-[(1-[(5-ethyl-1,3,4-thiadiazol-2-yl)amino]carbonyl)cyclopentyl)methyl]pentanoic acid.



Trifluoroacetic acid (5ml) was added to a solution of the title product from stage b) above (0.31mmol) in dichloromethane (5ml), and the solution stirred at room temperature for 4 hours. The reaction mixture was concentrated under reduced pressure and the residue azeotroped with toluene and dichloromethane to afford the title compound as a clear oil, 81%, <sup>1</sup>H NMR (CDCl<sub>3</sub>, 400MHz) δ: 0.92 (t, 3H), 1.35 (t, 3H), 1.25-1.80 (m, 11H), 2.20-2.50 (m, 4H), 2.95 (q, 2H), 12.10 (bs, 1H); LRMS : m/z 339.8 (MH<sup>+</sup>); Anal. Found: C, 56.46; H, 7.46; N, 12.36. C<sub>16</sub>H<sub>25</sub>N<sub>3</sub>O<sub>3</sub>S requires C, 56.62; H, 7.44; N, 12.37%.

10

Details on a suitable assay system for identifying and/or studying an I:NEP are presented in the hereinafter in the section entitled NEP Assay. Further examples of NEP inhibitors are disclosed and discussed in the following review articles:

15

Pathol. Biol., 46(3), 1998, 191.  
Current Pharm. Design, 2(5), 1996, 443.  
Biochem. Soc. Trans., 21(3), 1993, 678.  
Handbook Exp. Pharmacol., 104/1, 1993, 547.  
TiPS, 11, 1990, 245.

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Pharmacol. Rev., 45(1), 1993, 87.  
Curr. Opin. Inves. Drugs, 2(11), 1993, 1175.  
Antihypertens. Drugs, (1997), 113.  
Chemtracts, (1997), 10(11), 804.  
Zinc Metalloproteases Health Dis. (1996), 105.

25

Cardiovasc. Drug Rev., (1996), 14(2), 166.  
Gen. Pharmacol., (1996), 27(4), 581.  
Cardiovasc. Drug Rev., (1994), 12(4), 271.  
Clin. Exp. Pharmacol. Physiol., (1995), 22(1), 63.  
Cardiovasc. Drug Rev., (1991), 9(3), 285.

Exp. Opin. Ther. Patents (1996), 6(11), 1147.

Yet further examples of NEPi's are disclosed in the following documents:

**EP-509442A**

US-192435

US-4929641

EP-599444B

US-884664

EP-544620A

US-798684

J. Med. Chem. 1993, 3821.

Circulation 1993, 88(4), 1.

EP-136883

JP-85136554

US-4722810

Curr. Pharm. Design, 1996, 2, 443.

EP-640594

J. Med. Chem. 1993, 36(1), 87.

EP-738711-A

JP-270957

CAS # 115406-23-0

DE-19510566

DE-19638020

EP-830863

JP-98101565

EP-733642

WO9614293

JP-08245609

JP-96245609

WO9415908

JP05092948

WO-9309101

WO-9109840

EP-519738

EP-690070

J. Med. Chem. (1993), 36, 2420.

JP-95157459

Bioorg. Med. Chem. Letts., 1996, 6(1), 65.

Further I:NEPs are disclosed in the following documents:

EP-A-0274234

JP-88165353

Biochem.Biophys.Res. Comm.,1989, 164, 58

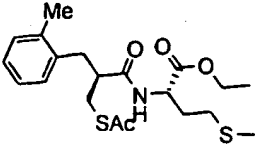
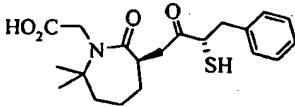
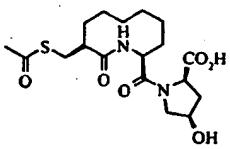
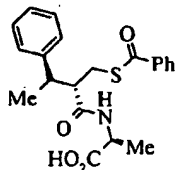
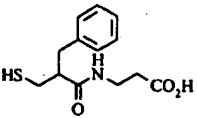
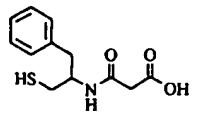
EP-629627-A

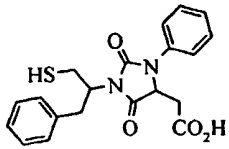
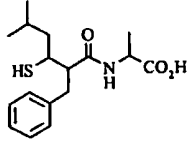
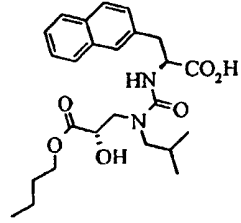
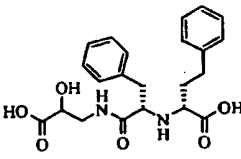
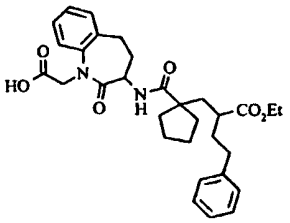
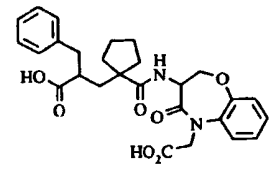
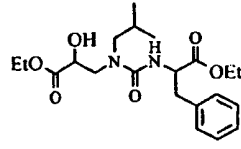
US-77978

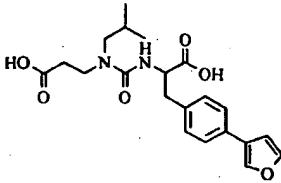
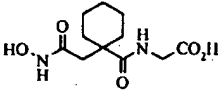
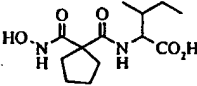
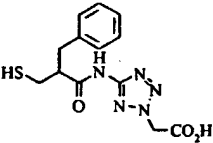
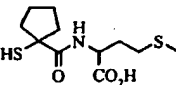
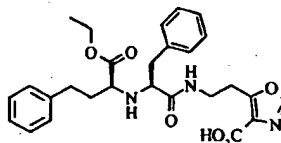
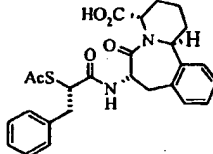
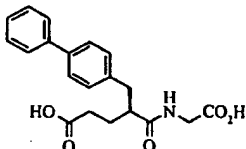
Perspect. Med. Chem. (1993), 45.

EP-358398-B

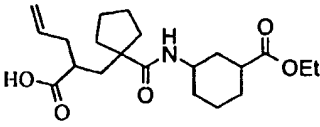
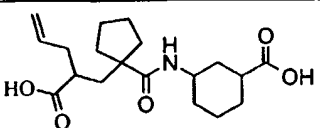
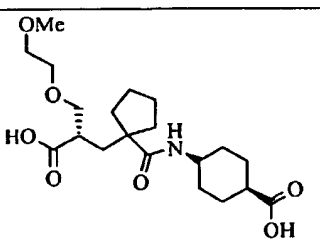
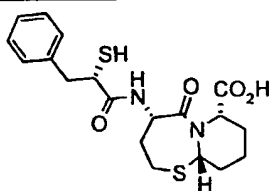
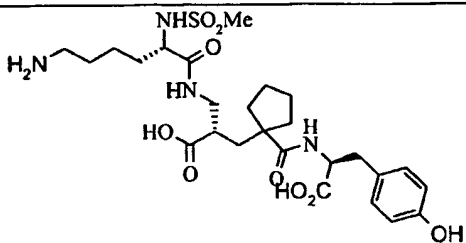
Further examples of I:NEPs are selected from the following structures:

Compound	Structure	Mode of Action References
FXII		<b>I:NEP</b> <b>EP-509442A</b> US-192435 US-4929641
FXIII		<b>I:NEP</b> (also an ACE inhibitor) <b>EP-599444B</b> US-884664
FXIV		<b>I:NEP</b> <b>EP-544620A</b> US-798684 J. Med. Chem. 1993, 3821.
FXV		<b>I:NEP</b> (also an ACE inhibitor) Mizanpril Circulation 1993, <u>88</u> (4), 1.
FXVI		<b>I:NEP</b> <b>EP-136883</b> JP-85136554 US-4722810
FXVII		<b>I:NEP</b> Retrothiorphan Curr. Pharm. Design, 1996, 2, 443.

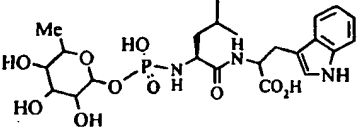
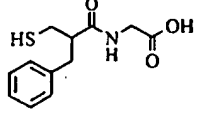
FXVIII		I:NEP (also an ACE inhibitor) EP-640594
FXIX		I:NEP J. Med. Chem. 1993, 36(1), 87.
FXX		I:NEP (also an ACE inhibitor) EP-738711-A JP-270957
FXXI		I:NEP CAS # 115406-23-0
FXXII		I:NEP (also an ECE inhibitor) DE-19510566 DE-19638020 EP-830863 JP-98101565
FXXIII		I:NEP (also an ECE inhibitor) EP-733642
FXXIV		I:NEP WO96/14293

FXXV		I:NEP JP-08245609 JP-96245609
FXXVI		I:NEP WO9415908
FXXVII		I:NEP JP05092948
FXXVIII		I:NEP WO-9309101
FXXIX		I:NEP WO-9109840
FXXXI		I:NEP EP-519738 EP-690070
FXXXII		I:NEP (also an ACE inhibitor) J. Med. Chem. (1993), 36, 2420.
FXXXIII		I:NEP JP-95157459 Bioorg. Med. Chem. Letts., 1996, 6(1), 65.

Preferred additional I:NEPs are selected from the following structures:

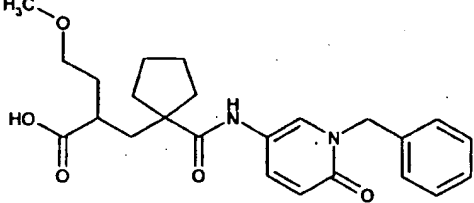
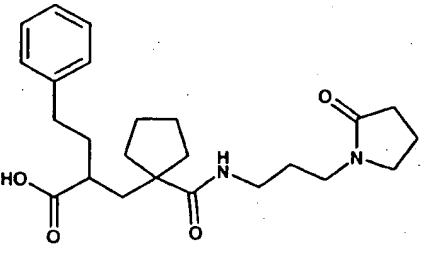
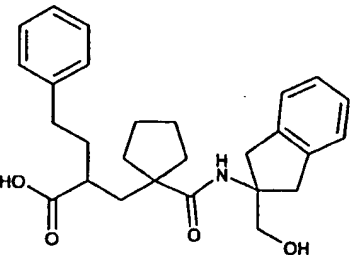
Compound	Structure	Mode of Action References
FV		I:NEP EP-A-0274234 (Example 300)
FVI		I:NEP EP-A-0274234 (Example 379)
FVII		I:NEP Candoxatrilat EP-274234 JP-88165353 Biochem.Biophys.Res. Comm.,1989, <u>164</u> , 58
FVIII		I:NEP Omapatrilat (also an inhibitor of ACE) EP-0629627-A US-77978
FIX		I:NEP Sampatrilat (also an inhibitor of ACE) Perspect. Med. Chem. (1993), 45. EP-0358398-B

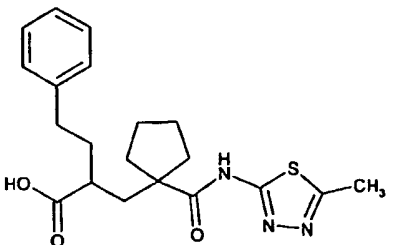
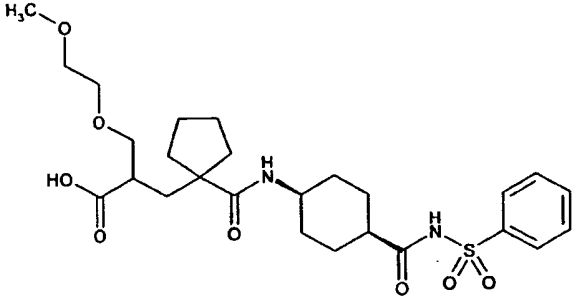
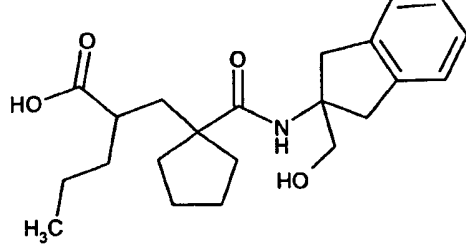
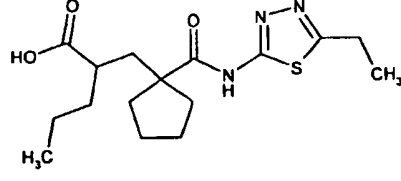
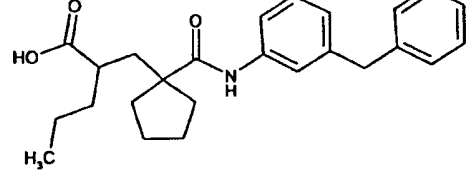
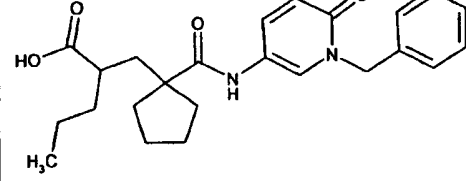


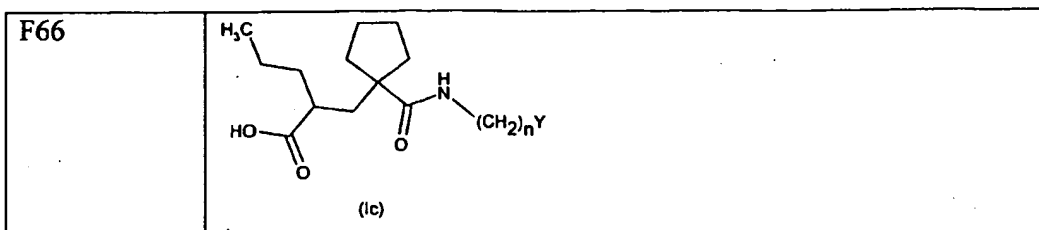
FX		I:NEP Phosphoramidon (which is commercially available)
FXI		I:NEP Thiorphan (which is commercially available)

More preferred additional I:NEPs are selected from the following structures:

5

COMPOUND	STRUCTURE
F57	
F58	
F59	

F60	 <chem>CC1=CN=NC(=N1)NC(=O)C2(CCCC2)C(C(=O)O)CC3=CC=CC=C3</chem>
F61	 <chem>COCCOCC(C(=O)O)C2(CCCC2)C(=O)N3CCCCC3C(=O)NS(=O)(=O)c4ccccc4</chem>
F62	 <chem>CCCC(C(=O)O)C2(CCCC2)C(=O)N3CC(O)CC3c4ccccc4</chem>
F63	 <chem>CCCC(C(=O)O)C2(CCCC2)C(=O)N1C=NC(=C1S)CC</chem>
F64	 <chem>CCCC(C(=O)O)C2(CCCC2)C(=O)Nc1ccc(cc1)Cc2ccccc2</chem>
F65	 <chem>CCCC(C(=O)O)C2(CCCC2)C(=O)Nc1ccc2c(c1)c(=O)n(Cc3ccccc3)c2=O</chem>



### BIOAVAILABILITY

- 5            Preferably, the compounds of the invention (and combinations) are orally bioavailable. Oral bioavailability refers to the proportion of an orally administered drug that reaches the systemic circulation. The factors that determine oral bioavailability of a drug are dissolution, membrane permeability and metabolic stability. Typically, a screening cascade of firstly *in vitro* and then *in vivo* techniques
- 10          is used to determine oral bioavailability.

- Dissolution, the solubilisation of the drug by the aqueous contents of the gastro-intestinal tract (GIT), can be predicted from *in vitro* solubility experiments conducted at appropriate pH to mimic the GIT. Preferably the compounds of the
- 15          invention have a minimum solubility of 50 mcg/ml. Solubility can be determined by standard procedures known in the art such as described in Adv. Drug Deliv. Rev. 23, 3-25, 1997.

- Membrane permeability refers to the passage of the compound through the cells of the GIT. Lipophilicity is a key property in predicting this and is defined by *in vitro* Log  $D_{7.4}$  measurements using organic solvents and buffer. Preferably the
- 20          compounds of the invention have a Log  $D_{7.4}$  of -2 to +4, more preferably -1 to +2. The log D can be determined by standard procedures known in the art such as described in J. Pharm. Pharmacol. 1990, 42:144.

25

Cell monolayer assays such as CaCo<sub>2</sub> add substantially to prediction of favourable membrane permeability in the presence of efflux transporters such as p-

glycoprotein, so-called caco-2 flux. Preferably, compounds of the invention have a caco-2 flux of greater than  $2 \times 10^{-6} \text{cms}^{-1}$ , more preferably greater than  $5 \times 10^{-6} \text{cms}^{-1}$ . The caco flux value can be determined by standard procedures known in the art such as described in J. Pharm. Sci, 1990, 79, 595-600

5

Metabolic stability addresses the ability of the GIT or the liver to metabolise compounds during the absorption process: the first pass effect. Assay systems such as microsomes, hepatocytes etc are predictive of metabolic liability. Preferably the compounds of the Examples show metabolic stability in the assay system that is commensurate with an hepatic extraction of less then 0.5. Examples of assay systems and data manipulation are described in Curr. Opin. Drug Disc. Devel., 201, 4, 36-44, Drug Met. Disp.,2000, 28, 1518-1523

Because of the interplay of the above processes further support that a drug will be orally bioavailable in humans can be gained by *in vivo* experiments in animals. Absolute bioavailability is determined in these studies by administering the compound separately or in mixtures by the oral route. For absolute determinations (% absorbed) the intravenous route is also employed. Examples of the assessment of oral bioavailability in animals can be found in Drug Met. Disp.,2001, 29, 82-87; J. Med Chem , 1997, 40, 827-829, Drug Met. Disp.,1999, 27, 221-226.

20

By cross reference herein to compounds contained in patents which can be used in accordance with invention, we mean the therapeutically active compounds as defined in the claims (in particular of claim 1) and the specific examples (all of which is incorporated herein by reference).

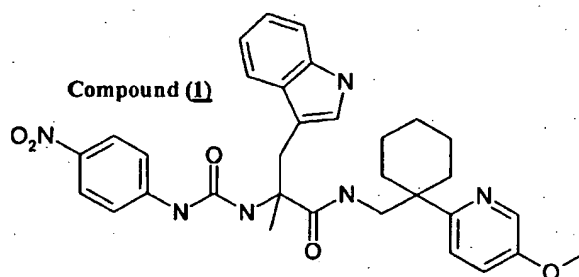
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How the invention may be put into effect will now be described, by way of example only, with reference to the following examples, some of which are preparative and others of which describe results of biological tests.

30

**Example 1**

**Effect of (S) 3-(1H-Indol-3-yl)-N-[1-(5-methoxy-pyridin-2-yl)-cyclohexyl-methyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide (Compound (1)) on female**  
5 **rat sexual proceptivity**



Ovariectomised adult female Sprague Dawley rats (180-200g, from Charles  
10 River) were housed in groups of 6 in a reversed lighting system of 12h light:dark  
(lights off 7.00-19.00h). Two weeks after ovariectomy they were used for sexual  
activity tests. The experiments started at least 5h into the dark period.

Tests were carried out in a circular arena of 90cm diameter, surrounded by a  
15 30cm high wall. Two small cages with wire-mesh front (15x15cm) are fixed into the  
wall such that the front of the cage is «flush» with the wall and the 2 cages are  
opposite each other. They contained two stimuli animals: an intact sexually  
experienced male and a receptive female (ovariectomised, primed with 5µg oestradiol  
benzoate dissolved in corn oil and injected subcutaneously 48 hours before the test  
20 and with 0.5 mg of progesterone four hours before the test). Sexually naive test and  
control animals were used. Forty eight hours before the tests, both the test and control  
animals were primed with 5µg oestradiol benzoate. For animals used as positive  
controls, progesterone (0.5mg/0.1ml) was dissolved in corn oil and administered  
subcutaneously (s.c.), 4h before the test. Test and control animals were introduced one  
25 at a time for 10 minute periods into the arena. During the 10min test, the time that the  
test or positive control animal spent investigating each stimulus animal was noted.  
The arena was thoroughly cleaned between animals. The position of the male/female

stimuli boxes was randomised between animals, in order to avoid place preference. The difference in the percentage of time spent investigating the male minus the female stimuli was calculated, out of the total time spent investigating stimuli animals.

5

Compound (1) was dissolved in 100%  $\beta$ -cyclodextrin and then diluted with saline to a final solution of 50% 2-hydroxypropyl- $\beta$ -cyclodextrin. It was administered intraperitoneally (i.p.) at doses of 3 and 10mg/kg, in a dosing volume of 1ml/kg, 1h before tests. Progesterone (0.5mg/0.1ml) was dissolved in corn oil and administered  
10 subcutaneously (s.c.), 4h before test, as a positive control.

Compound (1) dose-dependently (3mg/kg-10mg/kg) increased the percentage of time spent investigating the male stimulus, with a MED of 10mg/kg (see **Figure 1**). The effect of this dose was similar to the effect of progesterone (prog). (\*P<0.05,  
15 \*\*P<0.01 Kruskal-Wallis followed by Mann-Whitney test, vs vehicle).

## Example 2

### Effect of Compound (1) on female rat sexual receptivity

20

Ovariectomised adult female Sprague Dawley rats (180-200g, from Charles River) were housed in groups of 6 in a reversed lighting system of 12h light:dark (lights off 7.00-19.00h). Two weeks after ovariectomy they were used for sexual activity tests. The experiments started at least 5h into the dark period.

25

Compound (1) was dissolved in 100%  $\beta$ -cyclodextrin and then diluted with saline to a final solution of 50% 2-hydroxypropyl- $\beta$ -cyclodextrin. It was administered intraperitoneally (i.p.) at a dose of 10mg/kg, in a dosing volume of 1ml/kg. Quinelorane (6.25 $\mu$ g/kg) was dissolved in water and administered s.c. as positive  
30 control. Forty eight hours before testing, ovariectomised female rats (as described above), were primed with 5 $\mu$ g oestradiol benzoate dissolved in corn oil and injected subcutaneously. This is a low dose of oestrogen that does not re-establish sexual behaviour in an ovariectomised female but provides a minimum hormonal

background for pharmacological agents to stimulate sexual behaviour. The females were placed with a series of vigorous male rats and subjected to 10 mounts.

5 The lordotic response of the animal was recorded and expressed as a percentage of the mounts (i.e. lordosis quotient, LQ), as previously described. Animals showing LQ<20 were considered non-receptive and were included in the study. Each rat was tested prior to administration of the compound and then tested similarly post-injection. The pre-treatment times were 1h for Compound (1) and vehicle (50%  $\beta$ -cyclodextrin, i.p.) or 90min for quinelorane.

10

As shown in **Figure 2**, a single administration of quinelorane (6.25 $\mu$ g/kg, s.c.) significantly ( $P<0.01$ ) increased the LQ, 90min after administration, compared to the LQ shown before administration (paired t test). A single administration of Compound (1) (10mg/kg, i.p.) also had a significant ( $P<0.05$ ) stimulatory effect on the LQ, 1h after administration, compared to the LQ shown before administration (paired t test).

15

### Example 3

**The effect of repeated administration of Compound (1) on female rat proceptivity**

20

In the present study we have investigated whether the repeated administration of a higher dose of Compound (1) (15mg/kg) still results in stimulation of proceptivity.

25

Ovariectomised adult female Sprague Dawley rats (180-200g) were housed in groups of 5 in a reversed lighting system of 12h light:dark (lights off 5.00-17.00h). They were used for the experiments at least two weeks after ovariectomy. Forty eight hours before tests, the animals were primed with oestradiol benzoate (5 $\mu$ g/0.1ml in corn oil, s.c.). On day 1, progesterone (0.5mg/0.1ml, in corn oil, s.c.) was administered to one of the groups 4h before tests, as a positive control. Compound (1) (15mg/kg, i.p.) was administered in 50% 2-hydroxypropyl- $\beta$ -cyclodextrin, 1h before

30

tests. The test lasted 10 minutes and was carried out as described before. The difference in the percentage of time spent investigating the male minus the female stimuli was calculated, out of the total time spent investigating stimuli animals. Animals were submitted to a test on day 1 and on day 15. From day 2 to 14 the  
5 Compound (1) group received a daily injection of the compound (15mg/kg, i.p.), while both the vehicle and the progesterone groups received an injection of vehicle. On day 15 the test took place again, as described for day 1.

On day 1, both progesterone and Compound (1) had a stimulatory effect on  
10 proceptivity, compared to the vehicle group (\*\*P<0.01, ANOVA followed by Dunnett's test). On day 15, a similar stimulatory effect was observed (\*\*P<0.01, ANOVA followed by Dunnett's test) (see Figure 3). No significant difference was observed between the effects on day 1 and day 15 for each treatment group (paired t test). The effects of progesterone and Compound (1) were statistically similar. There were no  
15 changes in body weight or general behaviour between groups along the experiment.

From this study we can conclude that Compound (1) (15mg/kg, i.p.) has a stimulatory effect on proceptivity in the female rat, comparable to progesterone, and that such effect is unaffected by the repeated administration of the compound, which seems  
20 to be well tolerated.

#### Example 4

##### Effect of intracerebroventricular administration of Compound (1) on female rat 25 sexual proceptivity

In order to elucidate the site of action for this effect we have administered the Compound (1) intracerebroventricularly (i.c.v.).

30 Ovariectomised female rats (Sprague Dawley, obtained from Charles River, UK) were stereotaxically implanted (coordinates 0.89mm behind Bregma, 1.3mm lateral and 2.5mm vertical) with stainless steel cannulae (6 mm long, O.D. 0.75mm),



held in place with dental cement. Animals were housed in groups of three and returned to a reversed lighting system of 12h light:dark (lights off 5.00-17.00h).

Correct placement of the cannulae was assessed post-mortem. Rats were used for tests

~~.....two weeks and two weeks after ovariectomy (one week after cannulation). The experiments started at~~  
5 least 5h into the dark period. Forty eight hours before tests, the animals were primed with 5µg oestradiol benzoate (s.c. in corn oil) and adapted to the apparatus (in the absence of stimuli animals) for 10min on 2 consecutive days prior testing. The 10min test was carried out as previously described. The difference in the percentage of time spent investigating the male minus the female stimuli was calculated, out of the total  
10 time spent investigating stimuli.

Compound (1) was dissolved in 50% 2-hydroxypropyl-β-cyclodextrin in saline. It was administered i.c.v. over a 30sec period, with the aid of a pump set to deliver a flow of 10µl/min. The dosing volume was 5µl/rat. The compounds were  
15 administered 10min before tests. Progesterone (0.5mg/0.1ml) was dissolved in corn oil and administered subcutaneously (s.c.), 4h before test, as a positive control. As shown in **Figure 4**, Compound (1) dose-dependently (3-30µg/rat) increased the percentage of time spent investigating the male stimulus, with a MED of 10µg. The effect of this dose was similar to the effect of progesterone.

20

From this study we can conclude that the effect of Compound (1) on female sexual proceptivity is centrally mediated.

In Figure 4 bars represent percentage of time spent investigating male, minus  
25 the percentage of time spent investigating the female stimuli±SEM, (n=7-8 per group). \*P<0.05, \*\*P<0.01 vs vehicle (Kruskal-Wallis ANOVA test followed by Mann-Whitney's test).

### Example 5

#### **Inhibitory effect of NMB on female rat sexual proceptivity and antagonism of this effect by Compound (1)**

5

We have investigated the potentially inhibitory effect of the BB<sub>1</sub> agonist neuromedin B (NMB) on female rat sexual proceptivity.

Ovariectomised female rats (Sprague Dawley, obtained from Charles River,  
10 UK) were stereotaxically implanted (coordinates 0.89mm behind Bregma, 1.3mm lateral and 2.5mm vertical) with stainless steel cannulae (6 mm long, O.D. 0.75mm), held in place with dental cement. Animals were housed in groups of three and returned to a reversed lighting system of 12h light:dark (lights off 5.00-17.00h). Correct placement of the cannulae was assessed post-mortem. Rats were used for tests  
15 two weeks after ovariectomy (one week after cannulation). The experiments started at least 5h into the dark period. Forty eight hours before tests, the animals were primed with 5µg oestradiol benzoate (OB) (s.c. in corn oil) and adapted to the apparatus (in the absence of stimuli animals) for 10min on 2 consecutive days prior testing. The 10min test was carried out as previously described. The difference in the percentage  
20 of time spent investigating male minus female was calculated, out of the total time spent investigating stimuli.

Progesterone (Prog, 0.5mg/0.1ml) was dissolved in corn oil and administered subcutaneously (s.c.), 4h before test, to induce proceptive behaviour. Compound (1)  
25 (15mg/kg, i.p.) was dissolved in 50% 2-hydroxypropyl-β-cyclodextrin in saline and administered 1h before the i.c.v. administration. Neuromedin B was obtained from Bachem, UK. It was dissolved in isotonic saline and administered i.c.v. over a 30sec period, with the aid of a pump set to deliver a flow of 10µl/min, 10min before tests. The dosing volume was 5µl/rat. Each rat received a total amount of 100ng.

30

As shown in **Figure 5**, progesterone (Prog) increased the percentage of time spent investigating the male stimulus, compared to the vehicle group, thus showing

stimulation of proceptive behaviour. NMB (100ng, i.c.v.) significantly reduced proceptivity in progesterone-treated rats. Moreover, pre-treatment with Compound (1) which acts as an antagonist (15mg/kg, i.p.) prevented the inhibitory effect of NMB. However, the blockade obtained with the dose of Compound (1) used was not total.

5

From the present study we can conclude that stimulation of BB1 receptors with an agonist results in inhibition of proceptive behaviour. This inhibitory effect may be prevented by the presence of an antagonist. e.g. Compound (1) In figure 5 the bars represent percentage of time spent investigating male, minus the percentage of time spent investigating the female stimuli $\pm$ SEM, (n=8-12 per group). \*\*\*P<0.001 vs progesterone (One-way ANOVA followed by Dunnett's test).

10

### Example 6

#### 15 **Demonstration that the effect of Compound (1) on female sexual behaviour is not mediated through sexual hormones**

Previous examples have shown that Compound (1) (nanomolar affinity "mixed" BB<sub>1</sub>/BB<sub>2</sub> receptor antagonist) has a dose-dependent stimulatory effect on sexual activity in the female rat, both on proceptivity and receptivity. Although the animals used in that study were ovariectomised, and therefore steroid hormones release can not be expected to occur in response to the compound, there is a possibility that the adrenal glands might secrete steroid hormones in response to Compound (1). If that was the case, the mediation of the stimulatory effects by progesterone would be relevant for rodents, but it would not be the case for primates. In the present study, we have investigated the potential effect of the bombesin receptor antagonist Compound (1) on secretion of progesterone. Oestradiol and pituitary hormones (Luteinising hormone (LH), follicle stimulating hormone (FSH) and prolactin) have also been analysed in the same animals.

20

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Ovariectomised adult female Sprague Dawley rats (180-200g) were housed in groups of 6 in a reversed lighting system of 12h light:dark (lights off 7.00-19.00h).

They were used for the experiments at least two weeks after ovariectomy. Forty eight hours before tests, the animals were primed with oestradiol benzoate (5µg/0.1ml in corn oil, s.c.). Progesterone (0.5mg/0.1ml, in corn oil, s.c.) was administered 4h before blood collection, as a positive control. Compound (1) (3-10mg/kg, i.p.) was administered in 50% 2-hydroxypropyl-β-cyclodextrin, 1h prior to blood collection. Blood was collected from the trunk, after decapitation. It was immediately centrifuged (3500r.p.m., 4°C, 5min) and the plasmas frozen until assayed for hormonal content, using commercially available radioimmunoassay kits (<sup>125</sup>I-labelled hormones) for oestradiol, progesterone, LH, FSH and prolactin.

10

A single administration of progesterone resulted in a significant increase in the progesterone plasma levels ( $P<0.05$ ), and a significant decrease in LH plasma levels ( $P<0.01$ ), compared to animals injected with vehicle (Kruskal-Wallis followed by Mann-Whitney test). However, Compound (1) (3-10mg/kg, i.p.) had no effect on the plasma levels of progesterone (Figure 6, where animals were pre-treated with 5µg oestradiol benzoate, s.c., 48h before the test. They were tested 1h or 4h post-injection of Compound (1) (3-10mg/kg, p.o.) or progesterone (0.5mg/0.1ml, s.c.) respectively. Values represent mean±SEM, (n=9 per group). \* $P<0.05$ , vs vehicle (Kruskal-Wallis followed by Mann-Whitney test, vs vehicle)), oestradiol (Figure 7, where animals were pre-treated with 5µg oestradiol benzoate, s.c., 48h before the test. They were tested 1h or 4h post-injection of Compound (1) (3-10mg/kg, p.o.) or progesterone (0.5mg/0.1ml, s.c.) respectively. Values represent mean±SEM, (n=6-7 per group)), prolactin (Figure 8, where animals were pre-treated with 5µg oestradiol benzoate, s.c., 48h before the test. They were tested 1h or 4h post-injection of Compound (1) (3-10mg/kg, p.o.) or progesterone (0.5mg/0.1ml, s.c.) respectively. Values represent mean±SEM, (n=10 per group)) LH (Figure 9, where animals were pre-treated with 5µg oestradiol benzoate, s.c., 48h before the test. They were tested 1h or 4h post-injection of Compound (1) (3-10mg/kg, p.o.) or progesterone (0.5mg/0.1ml, s.c.) respectively. Values represent mean±SEM, (n=10 per group). \*\* $P<0.01$ , vs vehicle (Kruskal-Wallis followed by Mann-Whitney test, vs vehicle)) or FSH (Figure 10, where animals were pre-treated with 5µg oestradiol benzoate, s.c., 48h before the test.

They were tested 1h or 4h post-injection of Compound (1) (3-10mg/kg, p.o.) or progesterone (0.5mg/0.1ml, s.c.) respectively. Values represent mean $\pm$ SEM, (n=10 per group).

5 From this experiment we can conclude that Compound (1) did not have an effect on the secretion of sexual hormones, thus suggesting that the effects of the compound on female sexual activity must be mediated by different mechanisms, maybe involving neurotransmitters.

10

### Example 7

#### Effect of Compound (1) on the sexual behaviour of normal male rats

The potentially stimulatory effect of Compound (1) on male sexual behaviour  
15 has been tested on sexually vigorous rats. Sprague Dawley male rats (Charles River, UK) were kept, 4 rats per cage, in a reversed lighting regime (12:12 hours, lights off at 5.00 h), with free access to food and water. The rats were pre-selected by being presented with a receptive female at 4 days intervals, i.e. every third day (having 2 clear days between presentations) until completing 6-7 days of baseline  
20 determination. The animals showing consistently vigorous behaviour (ejaculatory latencies <300s) were chosen for further experiments (n=24). Animals were randomised into three groups. All animals received all three treatments following a latin-square design. Treatments were administered once a week, with a baseline test in between treatments (4 days intervals between baseline and test day). Treatments were  
25 Compound (1) (15mg/kg, dissolved in 50% 2-hydroxypropyl- $\beta$ -cyclodextrin in saline), vehicle, or Fluoxetine (20mg/kg dissolved in 100% DMSO). All treatments were administered i.p. in a 1ml/kg volume, 1h before tests.

For all the sexual behaviour tests, the males were placed in an observation  
30 arena (50-60 cm diameter), starting 5 hours into the dark cycle and observed under red illumination. Three to 4 minutes after placing the male in the arena, a receptive female (ovariectomised, bearing a 7 mm Silastic implant of oestradiol benzoate) was

introduced to the arena and the following parameters noted: Mount Latency: time (in seconds) taken between introduction of female and first mount. A maximum time of 15 minutes (900 seconds) was allowed, and the test terminated if no mounts were recorded within that time (**Figure 11**), Intromission Latency: time (in seconds) taken  
5 between introduction of female and first intromission (**Figure 12**), Number of Mounts: to reach ejaculation. When ejaculation was not reached, the number of mounts was not analyzed, Number of Intromissions: to reach ejaculation. When ejaculation was not reached, the number of intromissions was not analyzed (**Figure 13** is number of mounts + intromissions), Ejaculation Latency: time (in seconds)  
10 taken from first intromission to ejaculation. A maximum time of 30 minutes (1800 seconds) was given, and the test terminated if ejaculation was not achieved in that time (**Figure 14**), and Refractory Period: time (in seconds) taken from ejaculation to the first mount of the next series of sexual activity. In those animals reaching ejaculation the test was terminated at the end of the refractory period, as indicated by  
15 the first mount of the next sexual cycle (**Figure 15**).

A one-way ANOVA followed by Dunnett's t test was used to compare treated vs vehicle groups each day of testing, for all the sexual behaviour parameters. (\*P<0.05, \*\*P<0.01; n=15-16).

20

Mount latency and intromission latency were significantly increased in the fluoxetine-treated group compared to the vehicle group. Ejaculation latency and refractory period were also increased in this group, showing a decrease in sexual performance as well as the decreased arousal. No changes were seen in the number of  
25 mounts and intromissions required to achieve ejaculation. Unlike Fluoxetine, Compound (**1**) had no effect on any of the parameters studied, at a dose shown to be stimulatory in sexually dysfunctional males (see example 9). From the present study we can conclude that Compound (**1**) has no effect on sexual behaviour in sexually vigorous males.

30

### Example 8

#### Effect of Compound (1) on the sexual behaviour of sexually dysfunctional male rats

5

Fluoxetine induces ejaculation delay, anorgasmy and loss of sexual desire in humans (Crenshaw and Goldberg, 1996). A model of male sexual dysfunction in the rat, induced by daily administration of fluoxetine until a significant detrimental effect on sexual behaviour (arousal and ejaculation) was established. The potentially  
10 stimulatory effect of Compound (1) on male sexual behaviour in these sexually dysfunctional male rats was examined. The effects of Compound (1) were compared to those of yohimbine. Preclinical and clinical studies suggest that yohimbine may be an effective treatment for sexual side-effects caused SSRI (Hollander, E., McCarley, A. (1993) *J. Clin. Psychiatry* 53:207-209. and Jacobsen).

15

Sprague Dawley male rats (Charles River, UK) were kept, 4 rats per cage, in a reversed lighting regime (12:12 hours, lights off at 5.00 h), with free access to food and water. The rats were pre-selected by being presented with a receptive female at 4 days intervals, i.e. every third day (having 2 clear days between presentations) until  
20 completing 6-7 trials of baseline determination. The animals showing consistently vigorous behaviour (ejaculatory latencies <300s) were chosen for further experiments. Animals were treated for 3 consecutive days with either vehicle (water) or fluoxetine (20mg/kg, i.p., in a 2ml/kg dosing volume). On the fourth day, the animals treated with water received vehicle (veh+veh) and the animals treated with fluoxetine  
25 received one of the three following treatments: Compound (1) (15mg/kg, dissolved in 50% 2-hydroxypropyl- $\beta$ -cyclodextrin in saline), vehicle (cyclodextrine), or yohimbine (2mg/kg dissolved in water). All treatments were administered i.p. in a 1ml/kg volume, 1h before tests.

30

For all the sexual behaviour tests, the males were placed in an observation arena (50-60 cm diameter), starting 5 hours into the dark cycle and observed under red illumination. Three to 4 minutes after placing the male in the arena, a receptive

female (ovariectomised, bearing a 7 mm Silastic implant of oestradiol benzoate) was introduced to the arena and the following parameters noted: Mount Latency: time (in seconds) taken between introduction of female and first mount. A maximum time of 15 minutes (900 seconds) was allowed, and the test terminated if no mounts were recorded within that time (**Figure 16**), Ejaculation Latency: time (in seconds) taken from first intromission to ejaculation. A maximum time of 30 minutes (1800 seconds) was given, and the test terminated if ejaculation was not achieved in that time (**Figure 17**), Percentage of males achieving ejaculation within 30 minutes was calculated (**Figure 18**).

A one-way ANOVA followed by Dunnett's t test was used to compare the fluoxetine+vehicle group and other groups for mount and ejaculatory latencies. Percentage of animals ejaculating was analysed using a Chi-square test followed by Fisher's test. (\*:  $P < 0.05$ , \*\*:  $P < 0.01$ , \*\*\*:  $P < 0.001$ ;  $n = 15-19$ ).

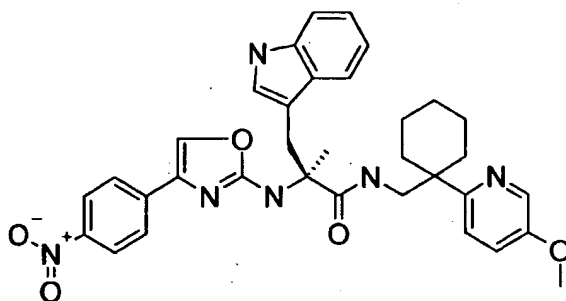
Mount latency and ejaculation latency were significantly increased in the fluoxetine-treated groups compared to the vehicle+vehicle group, indicating a decrease in sexual desire as well as sexual performance in these groups. The number of animals ejaculating was significantly lower in the fluoxetine-treated groups, indicating anorgasmy. Compound (**1**) significantly decreased the mount and ejaculatory latencies at the same time as increasing the percentage of animals ejaculating in the animals rendered sexually dysfunctional by the fluoxetine treatment, to levels comparable to normal animals (veh+veh). Yohimbine followed a similar trend, although this did not reach significance.

From the present study we can conclude a stimulatory effect of Compound (**1**) on sexual behaviour in males suffering from sexual dysfunction, at the level of sexual desire, sexual performance and anorgasmy.



## Example 9

(S)-3-(1*H*-Indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide



5

1. To a stirred solution of p-nitrophenylchloroformate (9.27g, 46mmol) in THF (200ml) at 0°C was added dropwise a solution of H-(S)- $\alpha$ MeTrp-OMe (**1a**) (10.7g, 46 mmol) and triethylamine (6.4ml, 46mmol) in THF (100ml) over 1 hour. Stirring was continued for a further 30 minutes at room temperature, after which aqueous ammonia (15ml) was added. IR after 10 minutes indicated bands at 1732 and 1660 cm<sup>-1</sup>. The THF was removed under reduced pressure, and the residue was taken up in EtOAc and washed with 1N HCl (x2), Na<sub>2</sub>CO<sub>3</sub> solution (until intense yellow colour subsided, ~x8), brine, and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure to give **2a** as a foam (10.3g, 82%): MS m/e (AP<sup>+</sup>): 276.16 (M<sup>+</sup> + H, 100%);

15

MS m/e (AP<sup>-</sup>): 274.11 (M<sup>-</sup> - H, 100%);

IR (film): 3383, 1724, 1657, 1600, 1539, 1456, 1374, 1256, 1108, 743 cm<sup>-1</sup>;

<sup>1</sup>H NMR (CDCl<sub>3</sub>):  $\delta$  = 1.70 (3H, s), 3.38 (1H, d, J=14.7 Hz), 3.59 (1H, d, J=14.7 Hz), 3.71 (3H, s), 4.22 (2H, s), 5.16 (1H, s), 6.99 (1H, d, J=2.2 Hz), 7.08-7.20 (2H, m), 7.34 (1H, d, J=8.1 Hz), 7.59 (1H, d, J=7.8 Hz), 8.09 (1H, s).

20

2. The urea (**2a**) (6.4g, 23mmol) and 2-bromo-1-(4-nitro-phenyl)-ethanone (6.0g, 23mmol) were stirred in toluene (500ml)/dioxan (100ml) and maintained under reflux for 30 hours, after which solvent was removed under reduced pressure and the residue

25

was purified by chromatography using a 90g Biotage cartridge. 10% EtOAc in heptane eluted the bromide starting material. 20% EtOAc eluted the desired product. Removal of solvent under reduced pressure gave **3a** as a foam (840mg, 9%):

MS m/e (ES<sup>+</sup>): 420.56 (M<sup>+</sup>, 100%);

5 IR (film): 3394, 1732, 1632, 1605, 1574, 1515, 1456, 1334, 1253, 1210, 1108, 1072, 940, 854, 734 cm<sup>-1</sup>;

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ= 1.91 (3H, s), 3.46 (1H, d, J=14.6 Hz), 3.69 (3H, s), 3.78 (1H, d, J=14.6 Hz), 5.57 (1H, s), 6.89 (1H, d, J=2.2 Hz), 7.03-7.08 (1H, m), 7.14-7.18 (1H, m), 7.34 (1H, d, J=8.1 Hz), 7.41 (1H, d, J=8.1 Hz), 7.63 (1H, s), 7.85 (2H, d, J=9.0 Hz), 8.05 (1H, s), 8.24 (2H, d, J=8.6 Hz).

3. The ester (**3a**) (840mg, 2mmol) was dissolved in dioxan (50ml) and LiOH.H<sub>2</sub>O (336mg, 8mmol) in H<sub>2</sub>O (25ml) was added. The mixture was stirred vigorously overnight, and then neutralised with 1M HCl (8ml, 8mmol). The majority of the dioxan was removed under reduced pressure and the product was crystallised, filtered off, washed with water and dried under reduced pressure to give pure **4a** (668mg, 82%):

MS m/e (ES<sup>+</sup>): 407 (M<sup>+</sup> + H);

IR (film): 1633 cm<sup>-1</sup>;

20 <sup>1</sup>H NMR (DMSO-d<sub>6</sub>) δ= 1.49 (3H, s), 3.30-3.35 (1H, m, masked by H<sub>2</sub>O), 3.59 (1H, d, J=14.7 Hz), 6.86-6.90 (1H, m), 6.99-7.03 (2H, m), 7.30-7.36 (2H, m), 7.48 (1H, s), 7.94 (2H, d, J=9.0 Hz), 8.27-8.30 (3H, m), 10.88 (1H, s), (CO<sub>2</sub>H not seen).

4. The acid (**4a**) (1.148g, 2.8mmol), *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (HBTU, 1.06g, 2.8mmol), and *N,N*-diisopropylethylamine (DIPEA, 490μl, 2.8mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (490μl, 2.8mmol) and [1-(5-methoxy-2-pyridyl)cyclohexyl]-methanamine (see WO 98/07718, 678mg, 3.1mmol). HPLC indicated that reaction was complete within 1 hour. Solvent was removed under reduced pressure and the residue was taken up in EtOAc. The organic layer was washed with brine, saturated NaHCO<sub>3</sub> (x3), brine and dried (MgSO<sub>4</sub>), after which solvent was removed under reduced pressure. The residue was purified by

chromatography using RP silica with 65% MeOH in H<sub>2</sub>O. Pure fractions were evaporated to give the desired product as an amorphous solid (1.12g, 66%):

MPt: 100-105°C;

MS m/e (ES<sup>+</sup>): 609.63 (M<sup>+</sup> + H, 100%);

5 IR (film): 3359, 3272, 3054, 2932, 2857, 1628, 1606, 1573, 1515, 1488, 1393, 1336, 1268, 1232, 1181, 1150, 1131, 1097, 1028, 1012, 962, 939, 900, 853, 831, 737 cm<sup>-1</sup>;

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ= 1.10-1.60 (8H, m), 1.72 (3H, s), 1.95-2.02 (2H, m), 3.31-3.42 (2H, m), 3.41 (1H, d, J=14.6 Hz), 3.50 (1H, d, J=14.6 Hz), 3.69 (3H, s), 5.34 (1H, s), 6.90-6.97 (2H, m), 7.04-7.09 (2H, m), 7.14-7.19 (1H, m), 7.33 (1H, d, J=8.1 Hz), 7.46 (1H, d, J=7.8 Hz), 7.54 (1H, s), 7.77 (2H, d, J=8.8 Hz), 8.00 (1H, d, J=2.9 Hz), 8.04 (1H, s), 8.21 (2H, d, J=8.8 Hz); (*amide masked by CHCl<sub>3</sub>*)

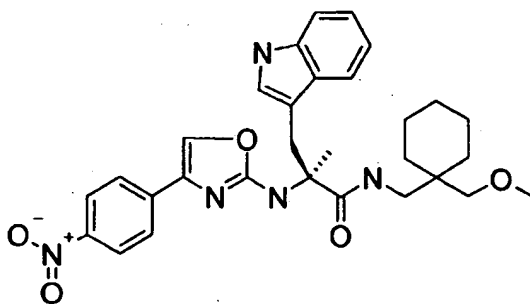
10 HPLC A: Rt. 11.86 min, 99.8/100% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1ml min<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm;

HPLC B: Rt. 14.32 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm.

### Example 10

20

(S)-3-(1*H*-Indol-3-yl)-*N*-(1-methoxymethyl-cyclohexylmethyl)-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide



The above compound was synthesized from Intermediate 4a and Intermediate 13 using the same method as used for **Example 9**. The acid (**4a**) (203mg, 0.5mmol), HBTU (190mg, 0.5mmol), and DIPEA (87 $\mu$ l, 0.5mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (87 $\mu$ l x 2, 1.0mmol) and **Intermediate 13** (94mg, 0.5mmol, Scheme 6). After 4 hours the solvent was removed under reduced pressure and residue taken up in EtOAc. The organic layer was washed with brine, saturated NaHCO<sub>3</sub> (x3), brine, dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was heated to 60°C in methanol and product filtered off. Drying under reduced pressure gave the desired product as a yellow crystalline solid (214mg, 78%):

MPt: 189-192°C;

MS m/e (ES<sup>+</sup>): 546.49 (M<sup>+</sup> + H, 100%);

IR (film): 3285, 2928, 2849, 1637, 1604, 1516, 1453, 1334, 1260, 1108, 1077, 860, 743, 729 cm<sup>-1</sup>;

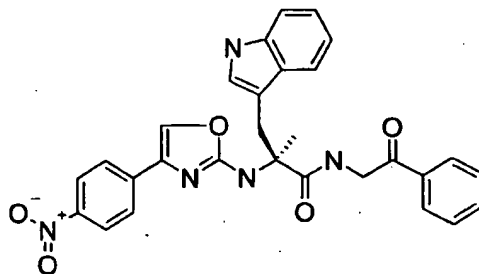
<sup>1</sup>H NMR (DMSO-d<sub>6</sub>):  $\delta$ = 1.10-1.35 (10H, m), 1.44 (3H, s), 2.91-3.01 (3H, m), 3.06-3.12 (1H, m), 3.07 (3H, s), 3.26-3.31 (1H, m), 3.64 (1H, d, J=14.4 Hz), 6.87-6.93 (2H, m), 7.01 (1H, t, J=7.4 Hz), 7.29-7.37 (3H, m), 7.44 (1H, s), 7.94 (2H, d, J=9.0 Hz), 8.26 (2H, d, J=8.8 Hz), 8.34 (1H, s), 10.84 (1H, s);

HPLC A: Rt. 17.07 min, 100/100% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm;

HPLC B: Rt. 14.35 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm.

### Example 11

(S)-3-(1*H*-Indol-3-yl)-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-*N*-(2-oxo-2-phenyl-ethyl)-propionamide.



The above compound was synthesised from **Intermediate 4a** using the same method as used for **Example 9**. The acid (**4a**) (203mg, 0.5mmol), HBTU (190mg, 0.5mmol), and DIPEA (87μl, 0.5mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (87μl, 0.5mmol) and 2-amino-1-phenyl-ethanone (103mg, 0.6mmol). After 4 hours the solvent was removed under reduced pressure and residue taken up in EtOAc, washed with brine, saturated NaHCO<sub>3</sub> (x3), brine, dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was purified by chromatography using NP 20g Mega Bond Elut cartridge and 40% ethyl acetate in heptane as eluent. Evaporation of pure fractions gave the desired product as a yellow amorphous solid (170mg, 65%):

MPt: 80-90°C;

MS m/e (AP+): 525.83 (16%), 524.44 (M<sup>+</sup> + H, 100%);

IR (film): 3396, 3059, 2983, 2932, 1694, 1628, 1605, 1575, 1514, 1449, 1336, 1284, 1264, 1225, 1181, 1154, 1096, 1072, 1010, 1001, 940, 853, 737 cm<sup>-1</sup>;

<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ= 1.50 (3H, s), 3.39 (1H, d, J=14.7 Hz), 3.64 (1H, d, J=14.6 Hz), 4.53 (1H, d.d, J=18.1 and 5.4 Hz), 4.66 (1H, d.d, J=18.1 and 5.5 Hz), 6.87 (1H, t, J=7.4 Hz), 6.95 (1H, d, J=2.2 Hz), 7.00 (1H, t, J=7.4 Hz), 7.30 (1H, d, J=8.1 Hz), 7.34 (1H, d, J=8.1 Hz), 7.41 (1H, s), 7.50-7.55 (2H, m), 7.62-7.67 (1H, m), 7.94-7.99 (4H, m), 8.24 (1H, t, J=5.4 Hz), 8.27 (2H, d, J=9.0 Hz), 8.31 (1H, s), 10.86 (1H, s);

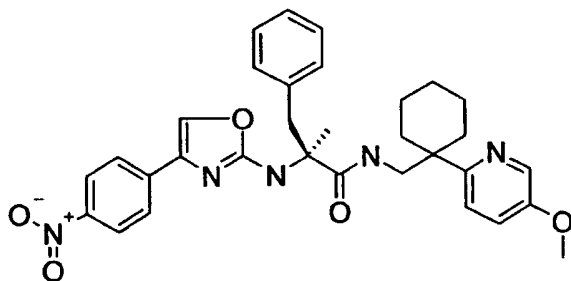
HPLC A: Rt. 20.83 min, 98.3/99.6% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 25 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm;

HPLC B: Rt. 6.82 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm.

### Example 12

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(S)-N-[1-(5-Methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-3-phenyl-propionamide



The above compound was synthesised from **1b** and **4b** using the same  
10 methods as used for **Example 9**. The acid (**4b**) (120mg, 0.33mmol), HBTU (124mg, 0.33mmol), and DIPEA (114μl, 0.66mmol), and [1-(5-methoxy-2-pyridyl)cyclohexyl]-methanamine<sup>1</sup> (86mg, 0.4mmol) were stirred in DMF (4ml) for 18 hours. Solvent removed under reduced pressure and residue taken up in EtOAc. The organic layer was washed with brine, saturated NaHCO<sub>3</sub> (x3), brine, dried  
15 (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was purified by chromatography using NP silica with 10-80% ethyl acetate in heptane. Pure fractions were evaporated to give the desired compound as a yellow amorphous solid (90mg, 49%):

MS m/e (AP+): 570.23 (M<sup>+</sup> + H, 100%);

20 IR (film): 3363, 2930, 2856, 1658, 1651, 1628, 1574, 1515, 1488, 1334, 1268, 1232, 1073, 1030, 938, 852 cm<sup>-1</sup>;

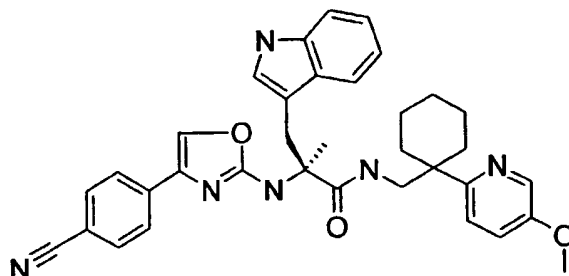
<sup>1</sup>H NMR (DMSO-d<sub>6</sub>): δ= 0.94-1.46 (11H, m), 1.98-2.10 (2H, m), 3.04-3.14 (2H, m), 3.25-3.32 (1H, m), 3.57 (1H, d, J=13.6 Hz), 3.73 (3H, s), 6.95-7.00 (3H, m), 7.10-7.24 (5H, m), 7.44 (1H, s), 7.93 (2H, d, J=8.8 Hz), 8.14 (1H, d, J=2.8 Hz), 8.27  
25 (2H, d, J=9.2 Hz), 8.36 (1H, s);

HPLC A: Rt. 5.49 min, 99.76% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA)  
over 7 min at 1.5 mlmin<sup>-1</sup>, Prodigy ODSIII 150x4.6mm 3μM at 40°C, 200-300 nm;

HPLC B: Rt. 5.72 min, 99.46% purity, 20-90% CH<sub>3</sub>CN/Tris (1mM) over 7  
min at 2mlmin<sup>-1</sup>, Prodigy Phenyl-Ethyl, 100x4.6mm 5μM at 30°C, 200-300 nm.

## Example 13

(S)-2-[4-(4-Cyano-phenyl)-oxazol-2-ylamino]-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-propionamide



5

The above compound was synthesized from **2a** via **6a** as outlined in Scheme 2 using methods analogous to those used for **Example 9**. The acid (**6a**) (309mg, 0.8mmol), HBTU (303mg, 0.8mmol), DIPEA (140μl, 0.8mmol) were stirred in DMF (5ml) for 5 minutes before adding DIPEA (140μl, 0.8mmol) and [1-(5-methoxy-2-  
10 pyridyl)cyclohexyl]-methanamine (WO 98/07718) (185mg, 0.84mmol). HPLC indicated reaction complete within 1 hour. Solvent removed under reduced pressure and residue taken up in EtOAc. Washed with brine, saturated NaHCO<sub>3</sub> (x3), brine, dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. Residue purified by chromatography using RP silica with 65% MeOH in H<sub>2</sub>O. Pure fractions were  
15 evaporated to give **Example 13** as a white amorphous solid (320mg, 68%):

MPt: 105-108°C;

MS m/e (ES<sup>+</sup>): 589.32 (M<sup>+</sup> + H, 100%), 590.18 (62%);

IR (film): 3355, 2932, 2857, 2225, 1628, 1572, 1521, 1489, 1456, 1328, 1269,  
20 1232, 1096, 1072, 1029, 938, 844, 741 cm<sup>-1</sup>;

<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ= 1.20-1.60 (8H, m), 1.70 (3H, s), 1.93-2.03 (2H, m),  
3.30-3.52 (4H, m), 3.68 (3H, s), 5.30 (1H, s), 6.89 (1H, d, J=2.4 Hz), 6.94 (1H, d.d,  
J=8.8 and 2.9 Hz), 7.03-7.09 (2H, m), 7.14-7.19 (1H, m), 7.20-7.25 (1H, m), 7.33  
(1H, d, J=8.1 Hz), 7.46 (1H, d, J=7.8 Hz), 7.50 (1H, s), 7.63 (2H, d, J=8.5 Hz), 7.72  
25 (2H, d, J=8.3 Hz); 8.00 (1H, d, J=2.9 Hz), 8.05 (1H, s);

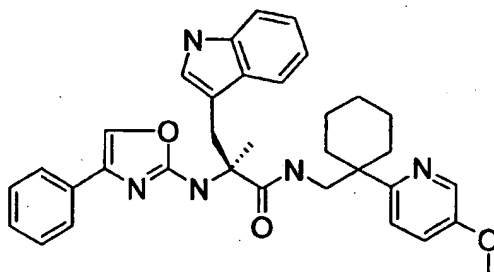


HPLC A: Rt. 11.63 min, 97.7/100% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm;

HPLC B: Rt. 9.20 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm.

#### Example 14

(S)-3-(1*H*-Indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-(4-phenyl-oxazol-2-ylamino)-propionamide



The above compound was synthesised from **2a** via **6b** as outlined in Scheme 2 using methods analogous to those used for **Example 9**. The acid (**6b**) (57mg, 0.148mmol), HBTU (56mg, 0.148mmol), DIPEA (26μl, 0.148mmol) were stirred in DMF (5ml) for 5 minutes before adding DIPEA (26μl, 0.148mmol) and [1-(5-methoxy-2-pyridyl)cyclohexyl]-methanamine (see WO 98/07718, 34mg, 0.148mmol). HPLC indicated that the reaction was complete within 2 hours. Solvent was removed under reduced pressure and the residue was taken up in EtOAc, washed with brine, sat. NaHCO<sub>3</sub> (x3), brine, dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was purified by chromatography using RP silica with 70% MeOH in H<sub>2</sub>O as eluent. Repurification using NP 8g Biotage cartridge with 45% ethyl acetate in heptane as eluent gave the desired product as a glass (20mg, 24%):

MPt: 85-90°C;

MS m/e (ES<sup>+</sup>): 564.06 (M<sup>+</sup>, 87%), 564.96 (M<sup>+</sup> + H, 100%);

IR (film): 3289, 2931, 2857, 1627, 1569, 1520, 1488, 1456, 1337, 1267, 1233, 1072, 1072, 1030, 939, 739  $\text{cm}^{-1}$ ;

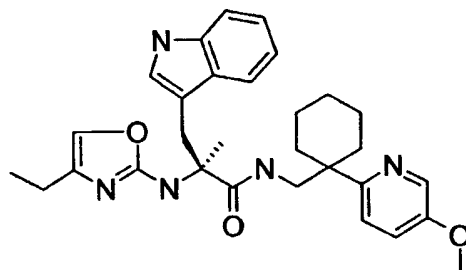
$^1\text{H}$  NMR ( $\text{DMSO-d}_6$ ):  $\delta$ = 0.95-1.45 (11H, m), 2.00-2.10 (2H, m), 3.10-3.25 (2H, m), 3.21 (1H, d,  $J$ =14.6 Hz), 3.59 (1H, d,  $J$ =14.6 Hz), 3.71 (3H, s), 6.84-7.14 (7H, m), 7.24-7.40 (5H, m), 7.70 (2H, d,  $J$ =7.6 Hz), 8.05 (1H, s), 8.15 (1H, d,  $J$ =2.9 Hz), 10.82 (1H, s);

HPLC A: Rt. 12.01 min, 96.8/95.3% purity, 20-100%  $\text{CH}_3\text{CN}$  in  $\text{H}_2\text{O}$  (+0.1%TFA) over 15 min at  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 215 and 254 nm;

10 HPLC B: Rt. 17.27 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9,  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 215 and 254 nm.

### Example 15

15 **(S)-2-(4-Ethyl-oxazol-2-ylamino)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-propionamide**



The above compound was synthesized from **2a** via **6c** as outlined in Scheme 2 using methods analogous to those used for **Example 9**. The acid (**6c**) (188mg, 0.6mmol), HBTU (228mg, 0.6mmol), and DIPEA (105 $\mu\text{l}$ , 0.6mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (105 $\mu\text{l}$ , 0.6mmol) and [1-(5-methoxy-2-pyridyl)cyclohexyl]-methanamine (see WO 98/07718, 150mg, 0.65mmol). HPLC indicated that the reaction was complete within 4 hours. Solvent was removed under reduced pressure and residue was taken up in EtOAc, washed with brine, sat.  $\text{NaHCO}_3$  (x3), brine, dried ( $\text{MgSO}_4$ ) and solvent removed under reduced pressure. The residue was purified by chromatography using RP silica with 65% MeOH in  $\text{H}_2\text{O}$ . The product was repurified using 20g Mega Bond Elut silica

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cartridge with 45% ethyl acetate in heptane as eluent. Pure fractions were evaporated to give the above compound as a glass (30mg, 10%):

MPt: 60-65°C;

MS m/e (ES+): 516.24 ( $M^+ + H$ , 47%), 517.01 (100%), 538.10 ( $M^+ + Na$ ,  
5 25%);

IR (film): 3272, 3054, 2931, 2856, 1651, 1622, 1596, 1573, 1520, 1489, 1457,  
1358, 1268, 1232, 1206, 1131, 1083, 1028, 949, 830, 740  $cm^{-1}$ ;

$^1H$  NMR (DMSO- $d_6$ ):  $\delta$ = 1.10-1.50 (8H, m), 1.11 (3H, t,  $J=7.4$  Hz), 1.29 (3H,  
s), 2.05-2.15 (2H, m), 2.28-2.34 (2H, m), 3.08-3.18 (3H, m), 3.48 (1H, d,  $J=14.4$  Hz),  
10 3.79 (3H, s), 6.80-6.90 (3H, m), 6.97-7.04 (2H, m), 7.10-7.20 (3H, m), 7.27-7.30  
(2H, m), 8.17 (1H, d,  $J=2.9$  Hz), 10.80 (1H, s);

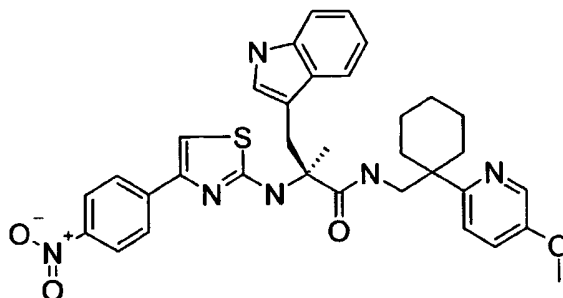
LCMS: Rt. 1.36 min, 100% purity, 5-100%  $CH_3CN$  in  $H_2O$  (+0.1% Formic  
acid) over 2 min at 4  $mlmin^{-1}$ , Prodigy ODSIII 50x4.6mm 5 $\mu M$ , 215 nm, MS m/e  
(ES+) 515.95 (100%);

15 HPLC B: Rt. 12.29 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9,  
1  $mlmin^{-1}$ , Prodigy ODSIII 250x4.6mm 5 $\mu M$ , 215 and 254 nm;

## Example 16

(S)-3-(1*H*-Indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-thiazol-2-ylamino]-propionamide

5



The above compound was synthesized using a one-pot procedure as outlined in Scheme 3. A suspension of H-S- $\alpha$ MeTrp-OH (**Intermediate 7**) (437mg, 2mmol), 2-chloro-4-(4-nitro-phenyl)-thiazole (see Peet, Norton P.; Sunder, Shyam. Reinvestigation of the reported preparation of 3-(4-nitrophenyl)thiazolo[2,3-c][1,2,4]triazepines, *J. Heterocycl. Chem.* (1986), 23(2), 593-5; 481mg, 2mmol), copper (I) iodide (38mg, 0.2mmol), and K<sub>2</sub>CO<sub>3</sub> (415mg, 3mmol) in DMF (12ml) under nitrogen was heated to 130°C for 12 hours. The reaction mixture was cooled to ambient temperature before adding HBTU (759mg, 2mmol) and [1-(5-methoxy-2-pyridyl)cyclohexyl]-methanamine (see WO 98/07718; 441mg, 2mmol). The mixture was stirred overnight, then concentrated in vacuo, after which the residue was partitioned between water (20ml) and dichloromethane (30ml). The organic phase was separated and filtered through silica (3x12cm) using 500ml of dichloromethane and then 500ml of dichloromethane-ether (1:1). Fractions containing product were concentrated under reduced pressure. The residue was absorbed onto 3.5g silica and purified by chromatography (3x11cm) using heptane-ethyl acetate (1:1.1). The product was repurified using RP chromatography (Biotage KP-C18-HS Flash 12M, 15ml.min<sup>-1</sup>, 60-100% methanol in water). Concentration under reduced pressure gave the desired compound as a pale yellow amorphous solid (27mg, 2%):

MPt: 110-114°C;

MS m/e (AP<sup>+</sup>): 624.88 (M<sup>+</sup>, 100%), 625.70 (M<sup>+</sup> + H, 52%);

IR (film): 3385, 3279, 2931, 2855, 1654, 1595, 1542, 1509, 1456, 1341, 1268, 1231, 1108, 1058, 908, 844, 731  $\text{cm}^{-1}$ ;

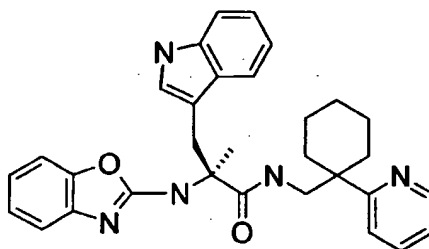
$^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.15-1.55 (8H, m), 1.71 (3H, s), 1.90-2.00 (2H, m), 3.16-3.42 (2H, m), 3.46 (1H, d,  $J$ =14.9 Hz), 3.60 (1H, d,  $J$ =14.6 Hz), 3.70 (3H, s), 5.51 (1H, s), 6.89-6.93 (3H, m), 6.98 (1H, d,  $J$ =8.8 Hz), 7.05-7.10 (1H, m), 7.15-7.25 (2H, m), 7.34 (1H, d,  $J$ =8.3 Hz), 7.47 (1H, d,  $J$ =7.8 Hz), 7.90 (2H, d,  $J$ =9.0 Hz), 7.98 (1H, d,  $J$ =2.9 Hz), 9.05 (1H, s), 8.21 (2H, d,  $J$ =8.8 Hz);

HPLC A: Rt. 12.30min, 99.4% purity, 20-100%  $\text{CH}_3\text{CN}$  in  $\text{H}_2\text{O}$  (+0.1%TFA) over 15 min at  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 200-300 nm;

10 HPLC B: Rt. 15.38min, 99.5% purity, 80:20 methanol/Tris buffer at pH9,  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 200-300 nm.

### Example 17

15 **(S)-2-(Benzooxazol-2-ylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide**



1. The following reagents were combined in the order that they are listed:  
20 **Intermediate 7** (545mg, 2.5mmol), 2-chlorobenzoxazole (384mg, 2.5mmol), potassium carbonate (346mg, 2.5mmol), benzyltriethylammonium chloride (TEBA, 114mg, 0.5mmol), triethylamine (1.04ml, 7.5mmol), DMF (12.5ml), deoxygenated water (1.25ml), copper (I) iodide (24mg, 0.125mmol), trans-dichlorobis(tri-*o*-tolylphosphine)palladium(II) (99mg, 0.125mmol). After heating at  $100^\circ\text{C}$  under nitrogen  
25 for 24 hours the DMF was removed under reduced pressure. The residue was taken up in ethyl acetate/water and the aqueous phase was acidified to pH 6-6.5 using citric

acid. The aqueous phase was extracted with three further portions of ethyl acetate. The combined organic layers were dried ( $\text{MgSO}_4$ ) and solvent was removed under reduced pressure. The residue was purified by chromatography using 10g NP silica with 0-100% ethyl acetate in heptane. Crystallisation from dichloromethane gave (S)-  
5 2-(benzooxazol-2-ylamino)-3-(1*H*-indol-3-yl)-2-methyl-propionic acid (245mg, 29%). MS m/e ( $\text{ES}^+$ ) 335.97 ( $\text{M}^+ + \text{H}$ , 100%), 336.69 (85%).

2. The propionic acid (234mg, 0.7mmol), HBTU (265mg, 0.7mmol), and DIPEA (122 $\mu\text{l}$ , 0.7mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA  
10 (122 $\mu\text{l}$ , 0.7mmol) and [1-(2-pyridyl)cyclohexyl]methylamine (WO 98/07718; 140mg, 0.74mmol). After 4 hours at ambient temperature the solvent was removed under reduced pressure. The residue was purified by chromatography using NP silica with 50% ethyl acetate in heptane as eluent. Pure fractions were evaporated to give the desired compound as fine needles (44mg, 3%):

15 MPt: 198-200°C;  
MS m/e ( $\text{ES}^+$ ): 508.59 (100%,  $\text{M}^+ + \text{H}$ ), 509.92 (10%);  
IR (film): 3381, 3222, 3048, 2929, 2856, 1635, 1581, 1552, 1519, 1458, 1353, 1241, 1096, 742  $\text{cm}^{-1}$ ;

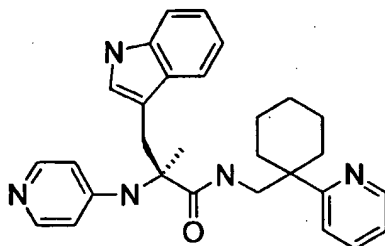
$^1\text{H}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.20–1.60 (8H, m), 1.76 (3H, s), 1.95–2.05 (2H, m),  
20 3.34 (1H, d.d,  $J=13.2$  and 4.9 Hz), 3.45 (1H, d.d,  $J=13.2$  and 5.6 Hz), 3.50 (2H, s), 5.67 (1H, s), 6.78–6.82 (1H, m), 6.89 (1H, d,  $J=2.2$  Hz), 6.99–7.35 (10H, m), 7.43 (1H, d,  $J=8.1$  Hz), 8.01 (1H, s), 8.24 (1H, d,  $J=4.6$  Hz);

HPLC A: Rt. 10.54 min, 100/100% purity, 20-100%  $\text{CH}_3\text{CN}$  in  $\text{H}_2\text{O}$  (+0.1%TFA) over 15 min at 1mlmin $^{-1}$ , Prodigy ODSIII 250x4.6mm 5 $\mu\text{M}$ , 215 and  
25 254 nm;

HPLC B: Rt. 10.67 min, 100/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin $^{-1}$ , Prodigy ODSIII 250x4.6mm 5 $\mu\text{M}$ , 215 and 254 nm;

## Example 18

**(S)-3-(1*H*-Indol-3-yl)-2-methyl-2-(pyridin-4-ylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide**



5           The above compound was prepared on the same scale and using an analogous method as used for **Example 17**.

1.       The method of **Example 17** was repeated except that 4-bromopyridine hydrochloride (486mg, 2.5mmol) was used.

10

2.       The acid from step 1 (30mg, 0.1mmol), HBTU (38mg, 0.1mmol), and DIPEA (18μl, 0.1mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (18μl, 0.1mmol) and [1-(2-pyridyl)cyclohexyl]methylamine (WO 98/07718; 19mg, 0.1mmol). After 2 hours at ambient temperature the solvent was removed under reduced pressure. The residue was taken up in ethyl acetate and washed with sodium bicarbonate solution (x2), brine, and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure. The crude product was purified by chromatography using 10g ISCO Redisep cartridge with ethyl acetate as eluent. Repurification using 20g RP-C18 with 70% methanol in water and subsequent evaporation gave the desired product in crystalline form (6mg, 13%):

15

20

MPt: 180-195°C;

MS m/e (AP<sup>+</sup>): 468.12 (M<sup>+</sup> + H, 100%), 469.59 (M<sup>+</sup> + 2H, 20%);

MS m/e (AP<sup>-</sup>): 467.56 (M<sup>-</sup>, 45%), 466.60 (M<sup>-</sup> - H, 100%), 465.64 (M<sup>-</sup> - 2H, 88%);

IR (film): 3316, 2930, 1651, 1602, 1515, 1430, 1106, 997, 816, 741  $\text{cm}^{-1}$ ;

NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.25–1.70 (8H, m), 1.46 (3H, s), 2.00–2.10 (2H, m), 3.27 (1H, d,  $J=14.9$  Hz), 3.30–3.48 (2H, m), 3.36 (1H, d,  $J=14.9$  Hz), 4.43 (1H, s), 6.22 (2H, d,  $J=5.6$  Hz), 6.85 (1H, d,  $J=2.0$  Hz), 6.89–6.93 (1H, m), 7.11–7.37 (5H, m),

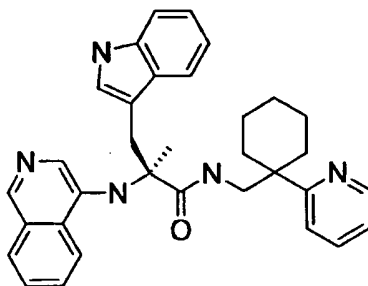
5 7.46–7.54 (2H, m), 8.08–8.13 (4H, m);

HPLC A: Rt. 7.21 min, 96.1/96.5% purity, 20–100%  $\text{CH}_3\text{CN}$  in  $\text{H}_2\text{O}$  (+0.1%TFA) over 15 min at  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 215 and 254 nm;

HPLC B: Rt. 6.02 min, 99.1/100% purity, 80:20 methanol/Tris buffer at pH9,  
10  $1\text{mlmin}^{-1}$ , Prodigy ODSIII 250x4.6mm  $5\mu\text{M}$ , 215 and 254 nm.

### Example 19

(S)-3-(1*H*-Indol-3-yl)-2-(isoquinolin-4-ylamino)-2-methyl-*N*-(1-pyridin-2-yl-  
15 cyclohexylmethyl)-propionamide



**Example 19** was prepared on the same scale and using an analogous method as used for **Example 17**.

1. The method of **Example 17** was followed except that 4-bromoisoquinoline  
20 (520mg, 2.5mmol) was used.

2. The acid from step 1 (40mg, 0.12mmol), HBTU (46mg, 0.12mmol), and DIPEA (21 $\mu\text{l}$ , 0.12mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (21 $\mu\text{l}$ , 0.12mmol) and [1-(2-pyridyl)cyclohexyl]methylamine (WO  
25 98/07718; 23mg, 0.12mmol). After 2 hours at ambient temperature the solvent was



removed under reduced pressure. The residue was taken up in ethyl acetate and washed with sodium bicarbonate solution (x2) and brine and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure. The crude product was purified by chromatography using 10g ISCO Redisepp cartridge with 80% ethyl acetate in heptane as eluent. Repurification using 20g RP-C18 with 70% methanol in water and subsequent evaporation gave the desired product as a glass (9mg, 14%):

MPt: 98-101°C;

MS m/e (AP<sup>+</sup>): 518.28 (100%, M<sup>+</sup> + H), 517.40 (M<sup>+</sup>, 50%);

MS m/e (AP<sup>-</sup>): 516.53 (75%, M<sup>-</sup>), 515.63 (100%, M<sup>-</sup> - H);

IR (film): 3385, 3278, 3052, 2927, 2849, 1651, 1585, 1520, 1455, 1403, 1343, 781, 740 cm<sup>-1</sup>;

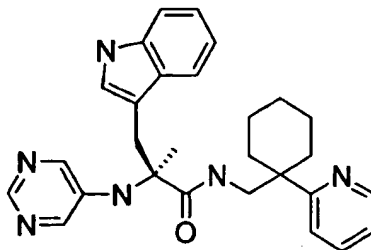
NMR (CDCl<sub>3</sub>): δ= 1.20–1.65 (11H, m), 1.93–2.10 (2H, m), 3.35 (1H, d, J=14.6Hz), 3.39–3.52 (2H, m), 3.48 (1H, d, J=14.9 Hz), 4.62 (1H, s), 6.55–6.59 (1H, m), 6.90 (1H, d, J=2.0 Hz), 7.00 (1H, d, J=8.1 Hz), 7.17–7.28 (4H, m), 7.37–7.55 (4H, m), 7.62 (1H, s), 7.70 (1H, d, J=7.6 Hz), 7.74–7.76 (1H, m), 7.87 (1H, d, J=8.1 Hz), 8.15 (1H, s), 8.63 (1H, s)

HPLC A: Rt. 7.52 min, 100/100% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm;

HPLC B: Rt. 8.33 min, 99.7/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm;

### Example 20

(S)-3-(1*H*-Indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(pyrimidin-5-ylamino)-propionamide

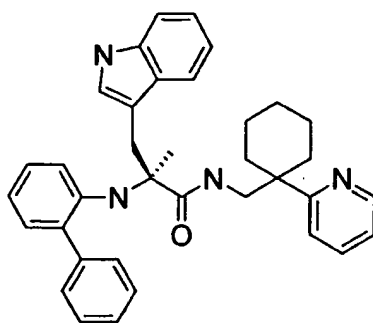


The above compound was prepared on the same scale and using an analogous method as used for **Example 17**.

1. The method of **Example 17** was followed except that 5-bromopyrimidine  
5 (397mg, 2.5mmol) was used.
2. The acid from step 1 (150mg, 0.5mmol), HBTU (190mg, 0.5mmol), and DIPEA (87 $\mu$ l, 0.5mmol) were stirred in DMF (10ml) for 5 minutes before adding DIPEA (87 $\mu$ l, 0.5mmol) and [1-(2-pyridyl)cyclohexyl]methylamine (WO 98/07718;  
10 95mg, 0.5mmol). After 2 hours at ambient temperature the solvent was removed under reduced pressure. The residue was taken up in ethyl acetate and washed with sodium bicarbonate solution (x2) and brine and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure. The crude product was purified by chromatography using 10g ISCO Redisep cartridge with 90% ethyl acetate in heptane as eluent.  
15 Removal of the solvent under reduced pressure gave the desired product as a foam (135mg, 58%):  
MPT: 95-98°C;  
MS m/e (AP<sup>+</sup>): 470.60 (25%), 469.58 (M<sup>+</sup> + H, 100%), 468.77 (M<sup>+</sup>, 92%);  
MS m/e (AP<sup>-</sup>): 467.60 (M<sup>-</sup> - H, 70%), 466.85 (100%);  
20 IR (film): 3291, 3052, 2931, 2857, 1651, 1575, 1519, 1470, 1455, 1427, 1357, 1306, 1265, 1237, 1194, 1156, 1106, 1010, 848, 788, 739 cm<sup>-1</sup>;  
NMR (CDCl<sub>3</sub>):  $\delta$ = 1.20–1.65 (8H, m), 1.48 (3H, s), 2.00–2.10 (2H, m), 3.24–3.48 (4H, m), 4.14 (1H, s), 6.88–6.92 (2H, m), 7.13–7.24 (3H, m), 7.37 (1H, d, J=8.1 Hz), 7.48–7.55 (3H, m), 7.86 (2H, s), 8.08–8.10 (1H, m), 8.16 (1H, s), 8.57 (1H, s);  
25 HPLC A: Rt. 8.94 min, 99.3/99.4% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm;  
HPLC B: Rt. 5.76 min, 95.1/98.7% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm.

**Example 21**

**(S)-2-(Biphenyl-2-ylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide**



5           The above compound was prepared on the same scale and using an analogous method as used for **Example 17**.

1.       The method of **Example 18** except for the use of 2-bromo biphenyl (583mg, 2.5mmols).

10

2.       The acid from step 1 (350mg, 0.95mmol), HBTU (400mg, 1mmol), NEt<sub>3</sub> (0.5ml, 3.5mmol), and 1-(2-pyridyl)cyclohexylmethylamine (WO 98/07718; 200mg, 1mmol) were stirred in DMF (15ml). After 1 hour at ambient temperature the reaction mixture was diluted with ethyl acetate (100ml), washed with sodium bicarbonate solution (x2) and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure. The crude product was purified by chromatography using 0-50% ethyl acetate in heptane and then 0-30% dichloromethane in ether as eluent. Removal of the solvent under reduced pressure gave the desired product as a foam (98mg, 19% for step 2):

20       MS m/e (AP<sup>+</sup>): 565 (M<sup>+</sup> + Na, 100%), 564 (80%), 542 (M<sup>+</sup>, 30%)

IR (KBr disc): 3404, 2928, 2855, 1650, 1584, 1508, 1489, 1458, 1432 cm<sup>-1</sup>;

NMR (DMSO-d<sub>6</sub>): δ = 1.10-1.52 (8H, m), 1.27 (3H, s), 1.95-2.05 (2H, m), 2.95 (1H, d, J=14.4 Hz), 3.02-3.08 (1H, m), 3.08 (1H, d, J=14.6 Hz), 3.28-3.34 (1H,

m), 4.36 (1H, s), 6.37 (1H, d, J=8 Hz), 6.49 (1H, d, J=2.2 Hz), 6.71-6.75 (1H, m), 6.82-6.86 (1H, m), 6.95-7.43 (13H, m), 7.52-7.57 (1H, m), 8.33 (1H, d, J=3.7 Hz), 10.81 (1H, s);

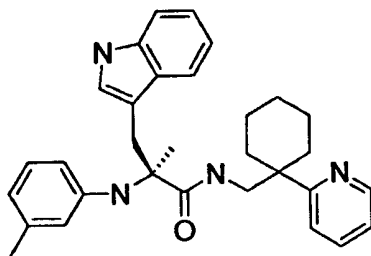
HPLC A: Rt. 12.65min, 99.65% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA)  
5 over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200-300 nm;

HPLC B: Rt. 33.05min, 99.89% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200-300 nm.

### Example 22

10

(S)-3-(1*H*-Indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-*m*-tolylamino-propionamide



The above compound was prepared using a one-pot procedure analogous to the method used for **Example 16**. The synthesis was carried out on 1mmol scale using  
15 1-bromo-3-methyl-benzene (171mg, 1mmol). The crude product was purified by chromatography using 25g NP silica with 25% ethyl acetate in heptane as eluent. Removal of the solvent under reduced pressure gave the desired compound as a glass (260mg, 54%):

MPt: 70-75°C;

20 MS m/e (AP<sup>+</sup>): 481.33 (100%, M<sup>+</sup> + H), 482.37 (40%);

IR (film): 3385, 3291, 3049, 2929, 2857, 1652, 1607, 1590, 1513, 1456, 1431, 1341, 1302, 1264, 1237, 1177, 1155, 1104, 1010, 774, 741 cm<sup>-1</sup>;

NMR (DMSO-d<sub>6</sub>): δ= 1.08-1.50 (8H, m), 1.19 (3H, s), 2.00-2.10 (2H, m), 2.16 (3H, s), 3.03 (1H, d.d, J=12.9 and 5.1 Hz), 3.10 (1H, d, J=14.7Hz), 3.22 (1H, d, J=14.6Hz), 3.24-3.30 (1H, m), 5.43 (1H, s), 6.29 (1H, s), 6.30 and 6.44 (each 1H,  
25

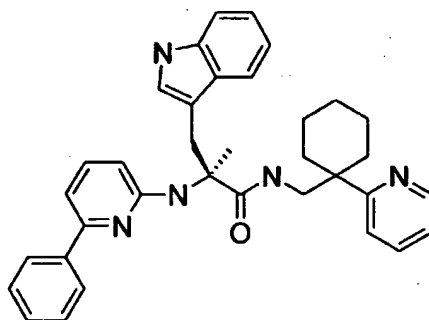
each d,  $J=7.6$  Hz), 6.87–7.07 (6H, m), 7.15–7.19 (1H, m), 7.29 (1H, d,  $J=8.0$  Hz), 7.33 (1H, d,  $J=7.8$  Hz), 7.48–7.54 (1H, m), 8.31–8.33 (1H, m), 10.81 (1H, s);

HPLC A: Rt. 11.04 min, 98.3% purity, 20–100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200–300 nm;

5 HPLC B: Rt. 16.87 min, 99.5% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200–300 nm.

### Example 23

10 (S)-3-(1*H*-Indol-3-yl)-2-methyl-2-(6-phenyl-pyridin-2-ylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide



The above compound was prepared using a one-pot procedure analogous to the method used for **Example 16**. The synthesis was carried out on 0.4mmol scale using 2-bromo-6-phenyl-pyridine (95mg, 0.4 mmol). The crude product was purified by chromatography using 25g NP silica with 55% ethyl acetate in heptane as eluent. Removal of the solvent under reduced pressure gave the desired product as a foam (260mg, 54%):

MS  $m/e$  (AP<sup>+</sup>) 544.31 (100%, M<sup>+</sup> + H), 545.35 (35%);

MS  $m/e$  (AP<sup>-</sup>) 542.29 (100%, M<sup>-</sup> - H), 543.31 (M<sup>-</sup>, 40%);

20 IR (film): 3407, 3276, 3056, 2930, 2857, 1651, 1595, 1576, 1519, 1486, 1467, 1455, 1439, 1339, 1264, 1180, 1157, 1105, 1028, 1009, 991, 804, 763, 739 cm<sup>-1</sup>;

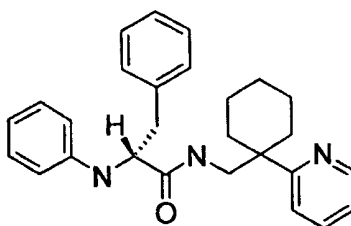
NMR (CDCl<sub>3</sub>)  $\delta$ = 1.03–1.60 (8H, m), 1.53 (3H, s), 1.90–2.03 (2H, m), 3.32–3.45 (3H, m), 3.65 (1H, d,  $J=14.6$ Hz), 4.67 (1H, s), 6.13 (1H, d,  $J=8.3$  Hz), 6.77–7.50 (14H, m), 7.97 (2H, d,  $J=7.1$  Hz), 8.02 (1H, s), 8.23–8.25 (1H, m);

HPLC A: Rt. 4.21 min, 96.8% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA)  
over 7 min at 1.5mlmin<sup>-1</sup>, Prodigy ODSIII 150x4.6mm 5μM, 200-300 nm.

### Example 24

5

**(R)-3-Phenyl-2-phenylamino-N-[1-pyridin-2-yl-cyclohexylmethyl]-propionamide**



The above compound was synthesised as a two step process from  
**Intermediate 8** as shown in Scheme 4.

10

1. To a solution of **Intermediate 8** (0.5g, 3mmol) and bromobenzene (0.35ml, 3.3mmol) in DMA (5ml) under nitrogen was added potassium carbonate (0.6g, 4.3mmol) and copper (I) iodide (50mg, 0.26mmol) after which the mixture was heated to 90°C for 1.5 hours. Solvent was removed under reduced pressure and the residue was purified by flash chromatography eluting with 5% methanol in dichloromethane. Removal of solvent under reduced pressure gave (R)-3-phenyl-2-phenylamino-propionic acid as an oil (0.41g, 56%):

MS m/e (AP<sup>+</sup>): 242 (M<sup>+</sup> + H, 100%).

2. The acid from step 1 (0.40g, 1.66mmol), HBTU (0.6g, 1.8mmol), and NEt<sub>3</sub> (0.5ml, 3.5mmol), and 1-(2-pyridyl)cyclohexyl]methylamine (WO 98/07718; 0.35mg, 1.8mmol) were stirred in DMF (15ml). After 1 hour at ambient temperature the reaction mixture was diluted with ethyl acetate (100ml), washed with sodium bicarbonate solution (x2) and dried (MgSO<sub>4</sub>). The solvent was removed under reduced pressure. The crude product was purified by chromatography using 50% ethyl acetate in heptane and then RP C18 silica with 70% methanol in water as eluent.

25

Removal of the solvent under reduced pressure gave the desired product as a white amorphous solid (0.15g, 22%):

MPt: 113-115°C;

MS m/e (AP<sup>+</sup>): 414.22 (M<sup>+</sup> + H, 100%);

5 IR (KBr disc): 3300, 2931, 2858, 1649, 1605, 1589, 1523, 1498, 1432, 1318, 748 cm<sup>-1</sup>;

NMR (CDCl<sub>3</sub>): δ = 1.20–1.70 (8H, m), 1.90–2.15 (2H, m), 2.91 (1H, d.d, J=14.2 and 8.8 Hz), 3.27 (1H, d.d, J=14.2 and 4.4 Hz), 3.38 (1H, d.d, J=13.2 and 5.5 Hz), 3.48 (1H, d.d, J=13.2 and 6.1 Hz), 3.80 (1H, d, J=3.4 Hz), 3.88–3.93 (1H, m), 6.44 (2H, d, J=7.8 Hz), 6.74 (1H, t, J=11.3 Hz), 6.90–7.45 (11H, m), 8.28 (1H, d, J=3.6 Hz);

HPLC A: Rt. 4.51 min, 100% purity, 20–100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 10 min at 1.5 mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200–300 nm;

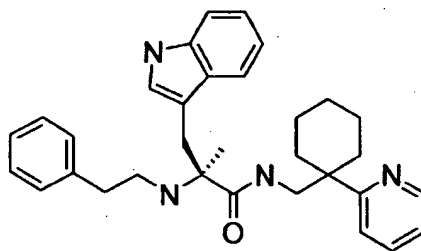
HPLC B: Rt. 13.15 min, 99.14% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 200–300 nm.

15

### Example 25

**(S)-3-(1*H*-Indol-3-yl)-2-methyl-2-phenylethylamino-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide**

20



The above compound was prepared as shown in Scheme 5 via **Intermediate 10**.

25 1. To a stirred solution of H-(S)-αMeTrp-OH (7) (10g, 46mmol) and di-*t*-butyl-dicarbonate (10g, 46mmol) in dioxan (100ml) was added water (20ml) and potassium

carbonate (10g, 74mmol). After 4 hours the reaction mixture was acidified with 2N hydrochloric acid (150ml) and product was extracted with ethyl acetate (2 x 200ml). The combined organic phases were dried (MgSO<sub>4</sub>) and evaporated under reduced pressure. The residue was purified by flash chromatography using ethyl acetate as eluent. Removal of solvent under reduced pressure gave Boc-(S)- $\alpha$ MeTrp-OH as an orange oil (14.5g, 99%). To a stirred solution of Boc-(S)- $\alpha$ MeTrp-OH (7g, 22mmol) in DMF (100ml) was added HBTU (8.0g, 22mmol), triethylamine (5ml, 35mmol), and [1-(2-pyridyl)cyclohexyl]methylamine (WO 98/07718; 4.2g, 22mmol). After 1 hour the reaction mixture was diluted with ethyl acetate (300ml), washed with 2N hydrochloric acid (2 x 200ml), dried (MgSO<sub>4</sub>) and evaporated under reduced pressure at 60°C. The residue was purified by flash chromatography. Elution with 5% methanol in dichloromethane and subsequent removal of solvent under reduced pressure gave intermediate 9 as yellow oil (8.3g, 77%):

MS m/e (AP+): 491 (M<sup>+</sup> + H, 100%), 513 (M<sup>+</sup> + Na, 20%);

IR (film): 3339, 2929, 2858, 1704, 1659, 1651, 1589, 1519, 1487, 1366, 1249, 1164, 1070, 908, 737 cm<sup>-1</sup>;

NMR (CDCl<sub>3</sub>):  $\delta$  = 1.20-1.70 (20H, m), 2.00-2.12 (2H, m), 3.25-3.50 (4H, m), 5.05-5.20 (1H, br.s), 6.92 (1H, d, J=2.0 Hz), 7.02-7.32 (6H, m), 7.51 (1H, d, J=8.0 Hz), 7.59-7.64 (1H, m), 8.03 (1H, s), 8.48 (1H, d, J=4 Hz).

20

2. To a stirred solution of **Intermediate 9** (8.2g, 16.5mmol) in dichloromethane (100ml) was added trifluoroacetic acid (3.0ml, 39mmol). After 18 hours the solvent was removed under reduced pressure at 60°C. The residue was treated cautiously with saturated sodium carbonate solution (200ml) before extracting with ethyl acetate (3 x 200ml). The combined organic phases were dried (MgSO<sub>4</sub>) and evaporated under reduced pressure at 60°C. The residue was purified by flash chromatography. Elution with 0-5% methanol in dichloromethane and subsequent removal of solvent under reduced pressure gave **Intermediate 10** as white foam (4.85g, 75%):

MPt: 65-68°C;

MS m/e (AP+): 391 (M<sup>+</sup> + H, 100%);

IR (KBr disc): 3367, 2926, 2855, 1648, 1589, 1569, 1522, 1455, 1430, 1366, 1341, 1234, 842, 784, 742 cm<sup>-1</sup>;



NMR (CDCl<sub>3</sub>):  $\delta$  = 1.20-1.80 (13H, m), 1.98-2.20 (2H, m), 2.83 (1H, d, J=14.2 Hz), 3.33 (1H, d, J=14.2 Hz), 3.38 (2H, d, J=5.6 Hz), 6.98-7.20 (6H, m), 7.50-7.75 (3H, m), 8.05-8.15 (1H, s), 8.49-8.51 (1H, m);

5 3. To a stirred solution of **Intermediate 10** (293mg, 0.75mmol) and phenacetaldehyde (90mg, 0.75mmol) in 1,2-dichloroethane (20ml) was added solid sodium triacetoxyborohydride (316mg, 1.5mmol). After stirring overnight, saturated sodium bicarbonate solution was added – effervescence was observed. The aqueous phase was extracted with dichloromethane. The combined organic phases were dried  
10 (MgSO<sub>4</sub>) and solvent was removed under reduced pressure. The residue was purified by chromatography using 20g RP-C18 with 0-50% methanol in water followed by 20g NP silica with 45% ethyl acetate in heptane. Removal of solvent under reduced pressure gave the desired compound as a glass (60mg, 16%):

MS m/e (ES<sup>+</sup>): 496.56 (28%), 495.5 (52%, M<sup>+</sup> + H), 364.43 (22%), 269.34  
15 (51%), 268.90 (88%), 248.37 (100%);

IR (film): 3274, 3058, 2928, 2856, 1651, 1588, 1568, 1519, 1469, 1454, 1431, 1355, 1263, 1236, 1155, 1117, 1053, 1030, 1009, 992, 930, 782, 742 cm<sup>-1</sup>;

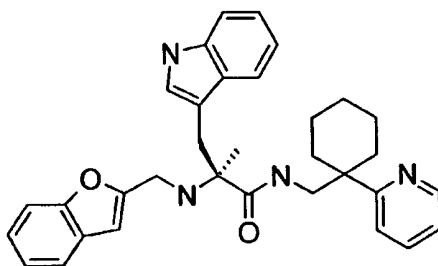
<sup>1</sup>H NMR (CDCl<sub>3</sub>):  $\delta$  = 1.20-1.65 (11H, m), 2.00-2.20 (2H, m), 2.40-2.75 (4H, m), 2.94 and 3.05 (each 1H, each d, J=14.4 Hz), 3.41 (2H, d, J=6.1 Hz), 6.74 (1H, d, J=2.2 Hz), 7.04-7.25 (9H, m), 7.32 (1H, d, J=7.8 Hz), 7.55-7.60 (3H, m), 7.90 (1H, s),  
20 8.55-8.58 (1H, m);

HPLC A: Rt. 8.52 min, 99.0/98.6% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm;

25 HPLC B: Rt. 23.84 min, 99.6/100% purity, 80:20 methanol/Tris buffer at pH9, 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5 $\mu$ M, 215 and 254 nm.

## Example 26

(S)-2-[(Benzofuran-2-ylmethyl)-amino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide



5

The above compound was prepared as shown in Scheme 5 via **Intermediate 10**.

To a stirred solution of **Intermediate 10** (150mg, 0.38mmol) and benzofuran-2-carbaldehyde (56mg, 0.38mmol) in 1,2-dichloroethane (5ml) was added solid sodium triacetoxyborohydride (162mg, 0.77mmol). After stirring at room temperature for 48 hours saturated sodium bicarbonate solution was added – effervescence was observed. The aqueous phase was extracted with ethyl acetate. The combined organic phases were dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was purified by chromatography using 60% ethyl acetate in heptane. Removal of solvent under reduced pressure gave the desired product as an amorphous white solid (29mg, 15%):

MS m/e (ES<sup>+</sup>): 521.08 (M<sup>+</sup> + H, 100%), 391.06 (50%);

IR (film): 3268, 3056, 2930, 2856, 1656, 1588, 1569, 1519, 1469, 1454, 1431, 1355, 1342, 1255, 1171, 1105, 1052, 1009, 909, 788, 740 cm<sup>-1</sup>;

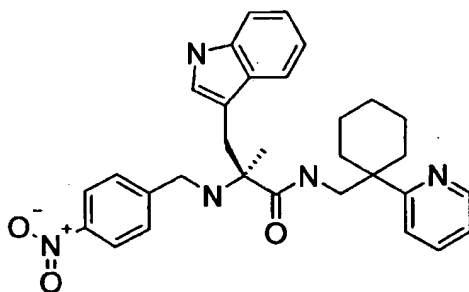
<sup>1</sup>H NMR (CDCl<sub>3</sub>): δ = 1.20-2.20 (14H, m), 3.08 (1H, d, J=14.4 Hz), 3.14 (1H, d, J=14.8 Hz), 3.45-3.49 (2H, m), 3.66 (1H, d, J=14.4 Hz), 3.76 (1H, d, J=14.8 Hz), 6.33 (1H, s), 6.84-6.88 (1H, m), 7.00-7.65 (12H, m), 8.32 (1H, s), 8.39 (1H, d, J=4.0 Hz);

HPLC A: Rt. 8.86 min, 99.7/99.1% purity, 20-100% CH<sub>3</sub>CN in H<sub>2</sub>O (+0.1%TFA) over 15 min at 1mlmin<sup>-1</sup>, Prodigy ODSIII 250x4.6mm 5μM, 215 and 254 nm.

5

**Example 27**

**(S)-3-(1*H*-Indol-3-yl)-2-methyl-2-(4-nitro-benzylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide**



The above compound was prepared as shown in Scheme 5 via **Intermediate**  
10 **10**. To a stirred solution of **Intermediate 10** (150mg, 0.38mmol) and 4-nitrobenzaldehyde (58mg, 0.38mmol) in 1,2-dichloroethane (5ml) was added solid sodium triacetoxyborohydride (114mg, 0.54mmol). After stirring at room temperature for 24 hours saturated sodium bicarbonate solution was added – effervescence was observed. The aqueous phase was extracted with ethyl acetate. The combined organic phases were dried (MgSO<sub>4</sub>) and solvent removed under reduced pressure. The residue was purified by chromatography using 60% ethyl acetate in heptane. Repurification using RP silica with 45% methanol in water (+ 1% acetic acid) gave pure product. The pure fractions were combined, basified (sodium carbonate), and extracted with ethyl acetate. Removal of solvent under reduced pressure gave the desired compound  
20 as a glass (10.5mg, 5%):

MPt: 58-60°C;

MS m/e (ES<sup>+</sup>): 526.15 (M<sup>+</sup> + H, 100%), 527.14 (33%);

IR (film): 3365, 2924, 2856, 1652, 1513, 1429, 1346, 1257, 1048 cm<sup>-1</sup>;

<sup>1</sup>H NMR (DMSO-*d*<sub>6</sub>): δ = 1.10-1.55 (8H, m), 1.19 (3H, s), 1.88-2.08 (2H, m), 2.25-  
25 2.30 (1H, m), 2.95-3.02 (2H, m), 3.10-3.20 (1H, m), 3.17-3.27 (1H, m), 3.50-3.80

(2H, m), 6.93-7.63 (11H, m), 8.12 (2H, d, J=8.8 Hz), 8.42 (1H, d, J=3.6 Hz), 10.86 (1H, s).

### Example 28

5

#### BB<sub>1</sub> and BB<sub>2</sub> Binding Assays

In the following experiments, measurement of BB<sub>1</sub> and BB<sub>2</sub> binding was as follows. CHO-K1 cells stably expressing cloned human NMB (for (BB<sub>1</sub> assay) and  
10 GRP receptors (for BB<sub>2</sub> assay) were routinely grown in Ham's F12 culture medium supplemented with 10% foetal calf serum and 2 mM glutamine. For binding experiments, cells were harvested by trypsinization, and stored frozen at -70°C in Ham's F12 culture medium containing 5% DMSO until required. On the day of use, cells were thawed rapidly, diluted with an excess of culture medium, and centrifuged  
15 for 5 minutes at 2000 g. Cells were resuspended in 50 mM Tris-HCl assay buffer (pH 7.4 at 21°C, containing 0.02% BSA, 40µg/mL bacitracin, 2µg/mL chymostatin, 4µg/mL leupeptin, and 2µM phosphoramidon), counted, and polytroned (setting 5, 10 sec) before centrifuging for 10 minutes at 28,000 g. The final pellet was resuspended in assay buffer to a final cell concentration of  $1.5 \times 10^5$ /mL. For binding  
20 assays, 200µL aliquots of membranes were incubated with [<sup>125</sup>I][Tyr<sup>4</sup>]bombesin (<0.1 nM) in the presence and absence of test compounds (final assay volume 250µL) for 60 minutes and 90 minutes for NMB and GRP receptors, respectively. Nonspecific binding was defined by 1µM bombesin. Assays were terminated by rapid filtration under vacuum onto Whatman GF/C filters presoaked in 0.2% PEI for >2 hours, and  
25 washed 50 mM Tris-HCl (pH 6.9 at 21°C; 6 × 1 mL). Radioactivity bound was determined using a gamma counter.

All competition data was analysed using nonlinear regression utilizing iterative curve-plotting procedures in Prism® (GraphPad Software Inc., San Diego,  
30 USA). IC<sub>50</sub> values were corrected to K<sub>i</sub> values using the Cheng-Prusoff equation (Cheng Y., Prusoff W. H., *Biochem. Pharmacol.* 22: 3099-3108, 1973).

The results obtained are listed in Table 1.

**Table 1 : Human NMB and GRP receptor binding affinities**

Example No.	NMB K <sub>i</sub> (nM)	GRP K <sub>i</sub> (nM)
9	4	24
10	469	
11	5580	
12	16	2820
13	19	1385
14	106	1190
15	213	1770
16	15	
17	2080	
18	303	
19	1249	
20	3163	
21	824	
22	653	
23	3371	
24	137	
25	616	2620
26	2400	
27	652	

5

### Example 29

**Effect of (S)-3-(1*H*-Indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide (Compound (2))**

10 **in PEG200 on female rat sexual proceptivity**

Ovariectomised adult female Sprague Dawley rats (180-200g, from Charles River) were housed in groups of 6 in a reversed lighting system of 12h light:dark (lights off 7.00-19.00h). Two weeks after ovariectomy they were used for sexual activity tests. Animals were adapted to the apparatus (in the absence of stimuli animals) for 10min on 2 consecutive days prior to testing. The experiments started at least 5h into the dark period.

Tests were carried out in a circular arena of 90cm diameter, surrounded by a 30cm high wall. Two small cages with wire-mesh front (15x15cm) are fixed into the wall such that the front of the cage is "flush" with the wall and the 2 cages are opposite each other. They contain two stimuli animals: an intact sexually experienced male and a receptive female (ovariectomised, primed with 5µg oestradiol benzoate dissolved in corn oil and injected subcutaneously 48 hours before the test and with 0.5 mg of progesterone four hours before the test). Sexually naive test and control animals were used. Forty eight hours before the tests, both the test and control animals were primed with 5µg oestradiol benzoate. Test animals were treated with the above compound (30-100mg/kg) which was dissolved in PEG 200 vehicle and administered orally in a 1ml/kg volume 1h before each test. For animals used as positive controls, progesterone (0.5mg/0.1ml) was dissolved in corn oil and administered subcutaneously (s.c.), 4h before the test. Test and control animals were introduced one at a time for 10 minute periods into the arena. During the 10min test, the time that the test or positive control animal spent investigating each stimulus animal was noted. The arena was thoroughly cleaned between animals. The position of the male/female stimuli boxes was randomised between animals, in order to avoid place preference. The difference in the percentage of time spent investigating male minus female was calculated, out of the total time spent investigating stimuli animals.

It was found (see **Figure 19**) that the above compound dose-dependently (30-100) increased the percentage of time spent investigating the male stimulus, with a MED of 100mg/kg (see below). The effect of this dose was similar to the effect of progesterone (maximal). (\*P<0.05, \*\*P<0.01 Kruskal-Wallis followed by Mann-Whitney test, vs vehicle).

### Example 30

#### Effect of Compound (2) in methyl cellulose on female rat sexual proceptivity.

5        Example 29 was repeated except that the above compound (3-30 mg/kg) was dissolved in 0.5% methyl cellulose and was administered p.o. in a dosing volume of 3ml/kg 1h before tests. Progesterone, (0.5mg/0.1ml) was dissolved in corn oil and administered s.c., 4h before test, as a positive control.

10        The above compound dose-dependently (3-30mg/kg) increased the percentage of time spent investigating the male stimulus, with a MED of 10mg/kg. This represents a 10-fold increase in potency compared to the oral results obtained in the PEG200 vehicle (MED=100mg/kg). The results are shown in **Figure 20** in which bars represent percentage of time spent investigating male, minus the percentage of time  
15        spent investigating the female stimuli $\pm$ SEM, (n=6-9 per group). \*P<0.05, \*\*P<0.01 vs vehicle (One-way ANOVA followed by Dunnett's test vs vehicle group).

### Example 31

#### Effect of Compound (2) in PEG 200 on female rat sexual receptivity.

20

      Ovariectomised adult female Sprague Dawley rats (180-200g, from Charles River) were housed in groups of 6 in a reversed lighting system of 12h light:dark (lights off 7.00-19.00h). Two weeks after ovariectomy they were used for sexual activity tests. The experiments started at least 5h into the dark period.

25

      The above compound was dissolved in PEG200 vehicle and administered orally. Quinelorane dihydrochloride (LY 163,502, 6.25 $\mu$ g/kg) was dissolved in water and administered subcutaneously (s.c.), as a positive control. Both compounds were administered in a 1ml/kg volume.

30

Forty eight hours before tests, the animals were primed with 5µg oestradiol benzoate (Sigma Chemical. Co. Ltd., UK) dissolved in corn oil and injected subcutaneously. The females were placed with a series of vigorous male rats and subjected to 10 mounts. The lordotic response of the animal was recorded and expressed as a percentage of the mounts (i.e. lordosis quotient, LQ). Treatment induced LQ=0-10% in most of the animals, which were considered non-receptive (NR). Animals showing higher LQ were not included in the study. Each rat was tested prior to administration of the compound and then tested similarly at 1h and 90min post-injection of the above compound or quinelorane respectively.

10

A single administration of quinelorane (6.25µg/kg) significantly ( $P<0.01$ ) increased the LQ, 90min after administration, compared to the LQ shown before administration (paired t test). A single oral administration of the above compound dose-dependently (10-100mg/kg) increased the LQ 1h after administration, with a MED of 100mg/kg ( $P<0.01$ ) compared to the LQ shown before administration (paired t test). The effect of the above compound (100mg/kg) was similar to the effect of quinelorane (6.25µg/kg) as is shown in **Figure 21**.

20

#### Synthesis Example (compounds of formula (III))

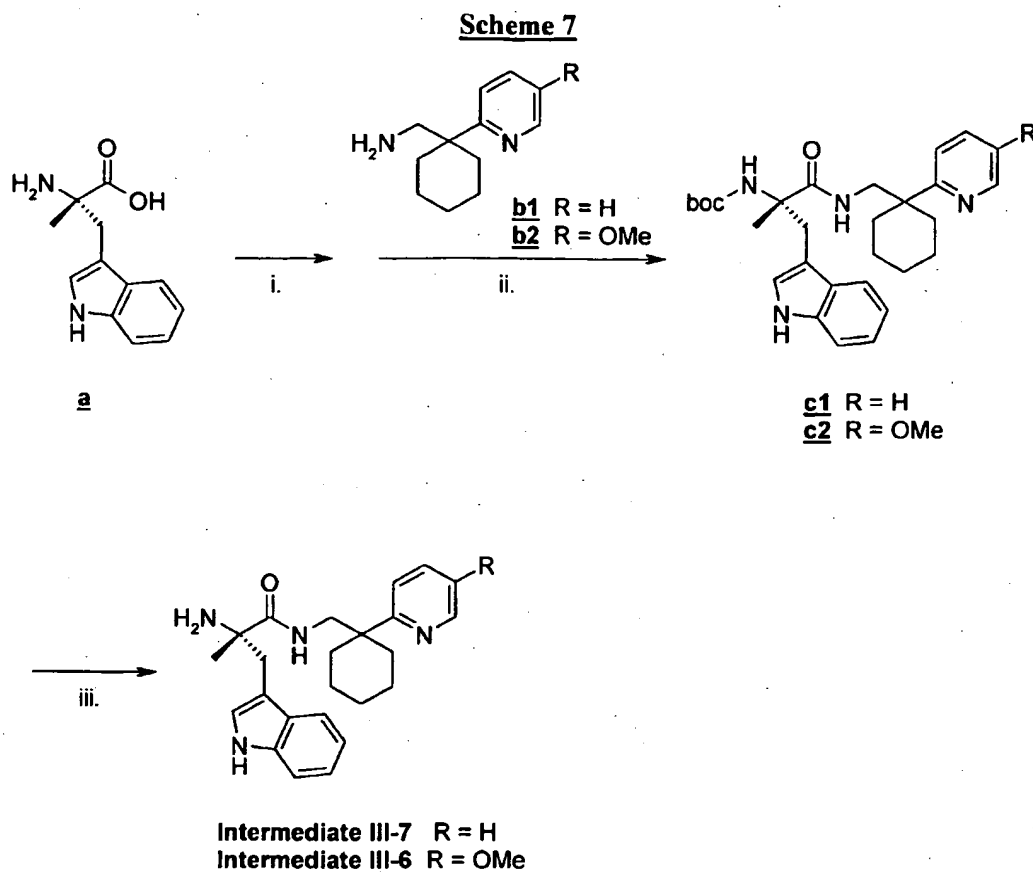
**(S)-2-Amino-3-(1 *H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide (Intermediate III-7) and**  
**(S)-2-Amino-3-(1 *H*-indol-3-yl)-2-methyl-*N*-(1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl)-propionamide (Intermediate III-6)**

25

In reaction scheme 7 below, Intermediates III-6 and III-7 are made by (i) protecting the amino group of the starting amino acid **a** with di-*t*-butyl carbonate and potassium carbonate in dioxane/water, (ii) forming an amide by reaction of the *N*-protected amino acid with an amine **b1** or **b2** in dimethylformamide in the presence of *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (HBTU) and *N,N*-diisopropyl-ethylamine (DIPEA), and (iii) deprotecting the amino group of the product **c1** or **c2** by reaction with trifluoroacetic acid in dichloromethane.

30





- 5    i.    BOC<sub>2</sub>O, K<sub>2</sub>CO<sub>3</sub>, dioxane, water  
      ii.    HBTU, DIPEA, DMF  
      iii.    TFA, CH<sub>2</sub>Cl<sub>2</sub>

10    **{{(S)-2-(1-*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-**  
      **carbamoyl]-ethyl}-carbamic acid *tert*-butyl ester (c1)**

- (1)    To a stirred solution of H-(S)-αMeTrp-OH (**a**) (10g, 46mmol) and di-*t*-butyl-  
      dicarbonate (10g, 46mmol) in dioxane (100ml) was added water (20ml) and  
      15    potassium carbonate (10g, 74mmol). After 4 hours the reaction mixture was acidified  
      with 2N hydrochloric acid (150ml) and product extracted with ethyl acetate (2 x  
      200ml). The combined organic phases were dried (MgSO<sub>4</sub>) and evaporated under

reduced pressure. The residue was purified by flash chromatography, eluting with ethyl acetate. Removal of solvent under reduced pressure gave Boc-(S)- $\alpha$ MeTrp-OH as orange oil (14.5g, 99%).

- 5 (2) To a stirred solution of Boc-(S)- $\alpha$ MeTrp-OH (7g, 22mmol) in DMF (100ml) was added HBTU (8.0g, 22mmol), triethylamine (5ml, 35mmol), and [1-(2-pyridyl)cyclohexyl]methylamine (**b1**, 4.2g, 22mmol, described in WO 98/07718). After 1 hour the reaction mixture was diluted with ethyl acetate (300ml) and washed with 2N hydrochloric acid (2 x 200ml), dried (MgSO<sub>4</sub>) and evaporated under reduced  
10 pressure at 60°C. The residue was purified by flash chromatography. Elution with 5% methanol in dichloromethane and subsequent removal of solvent under reduced pressure gave **c1** as yellow oil (8.3g, 77%):

IR (film): 3339, 2929, 2858, 1704, 1659, 1651, 1589, 1519, 1487, 1366, 1249, 1164, 1070, 908, 737 cm<sup>-1</sup>;

- 15 NMR (CDCl<sub>3</sub>):  $\delta$  = 1.20-1.70 (20H, m), 2.00-2.12 (2H, m), 3.25-3.50 (4H, m), 5.05-5.20 (1H, br.s), 6.92 (1H, d, J=2.0 Hz), 7.02-7.32 (6H, m), 7.51 (1H, d, J=8.0 Hz), 7.59-7.64 (1H, m), 8.03 (1H, s), 8.48 (1H, d, J=4 Hz);

MS m/e (AP+): 491 (M<sup>+</sup> + H, 100%), 513 (M<sup>+</sup> + Na, 20%).

- 20 (3) (S)-2-Amino-3-(1*H*-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexyl methyl)-propionamide (Intermediate III-7)

- To a stirred solution of **c1** (8.2g, 16.5mmol) in dichloromethane (100ml) was added trifluoroacetic acid (3.0ml, 39mmol). After 18 hours the solvent was removed  
25 under reduced pressure at 60°C. The residue was treated cautiously with saturated sodium carbonate solution (200ml) before extracting with ethyl acetate (3 x 200ml). The combined organic phases were dried (MgSO<sub>4</sub>) and evaporated under reduced pressure at 60°C. The residue was purified by flash chromatography. Elution with 0-5% methanol in dichloromethane and subsequent removal of solvent under reduced  
30 pressure gave **Intermediate III-7** as white foam (4.85g, 75%).

MPt: 65-68°C;

IR (KBr disc): 3367, 2926, 2855, 1648, 1589, 1569, 1522, 1455, 1430, 1366, 1341, 1234, 842, 784, 742  $\text{cm}^{-1}$ ;

NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.20-1.80 (13H, m), 1.98-2.20 (2H, m), 2.83 (1H, d,  $J=14.2$  Hz), 3.33 (1H, d,  $J=14.2$  Hz), 3.38 (2H, d,  $J=5.6$  Hz), 6.98-7.20 (6H, m), 7.50-7.75 (3H, m), 8.05-8.15 (1H, s), 8.49-8.51 (1H, m);

MS  $m/e$  ( $\text{AP}^+$ ): 391 ( $\text{M}^+ + \text{H}$ , 100%).

**{{(S)-2-(1-*H*-Indol-3-yl)-1-methyl-1-[(1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid *tert*-butyl ester (c2)**

10

To a stirred solution of Boc-(S)- $\alpha$ MeTrp-OH (1.44g, 4.5mmol) in DMF (50ml) was added HBTU (1.72g, 4.5mmol), DIPEA (2.38ml, 13.6mmol), and [1-(5-methoxy-2-pyridyl)cyclohexyl]methanamine (1g, 4.5mmol). After over night the reaction mixture was diluted with ethyl acetate (300ml) and water, dried ( $\text{MgSO}_4$ ) and evaporated under reduced pressure. The residue was purified by flash chromatography. Elution with ethylacetate/heptane (1:1) and subsequent removal of solvent under reduced pressure gave c2 as an oil (2.207g, 94%).

15

NMR ( $\text{CDCl}_3$ ):  $\delta$  = 1.24-1.60 (8H, m), 1.39 (9H, s), 1.52 (3H, s), 2.00-2.18 (2H, m), 3.20-3.43 (4H, m), 3.82 (3H, s), 6.92 (1H, d,  $J=2.4$  Hz), 7.02-7.20 (6H, m), 7.30 (1H, d,  $J=6.0$  Hz), 7.51 (1H, d,  $J=8\text{Hz}$ ), 8.00 (1H, s), 8.17 (1H, d,  $J=2.8\text{Hz}$ ).

20

MS  $m/e$  ( $\text{ES}^+$ ): 521.36 ( $\text{M}^+ + \text{H}$ , 100%), 543.25 ( $\text{M}^+ + \text{Na}$ ).

### Intermediate III-6

To a stirred solution of c2 (2.2g, 4.2mmol) in dichloromethane (10ml) was added trifluoroacetic acid (5ml, excess). After stirring over night the reaction mixture was taken up in 1N HCl and extracted with diethylether. Organic phase discarded. The aqueous phase was basified cautiously with saturated sodium carbonate solution before extracting with ethyl acetate (3 x 50ml). The combined organic phases were dried ( $\text{MgSO}_4$ ) and evaporated under reduced pressure at  $60^\circ\text{C}$  to give **Intermediate III-6** as a glass (1.253g, 71%).

30

IR (film): 3272, 2930, 2857, 1651, 1595, 1573, 1520, 1489, 1478, 1455, 1393, 1358, 1291, 1268, 1232, 1181, 1150, 1131, 1030, 1012, 831, 741  $\text{cm}^{-1}$ ;

NMR (DMSO):  $\delta$  = 1.10-1.65 (13H, m), 1.80-1.90 (1H, m), 2.00-2.10 (1H, m), 2.70 (1H, d,  $J=13.9$  Hz), 3.10 (1H, d,  $J=13.9$  Hz), 3.10-3.22 (2H, m), 3.77 (3H, s), 6.93-7.07 (4H, m), 7.16-7.19 (1H, m), 7.32 (1H, d,  $J=8.1$  Hz), 7.48-7.55 (2H, m), 8.21 (1H, d,  $J=3.2$  Hz), 10.88 (1H, s);

MS  $m/e$  (ES<sup>+</sup>): 421.27 ( $M^+ + H$ , 100%), 443.26 ( $M^+ + Na$ ).

### Examples 32-86

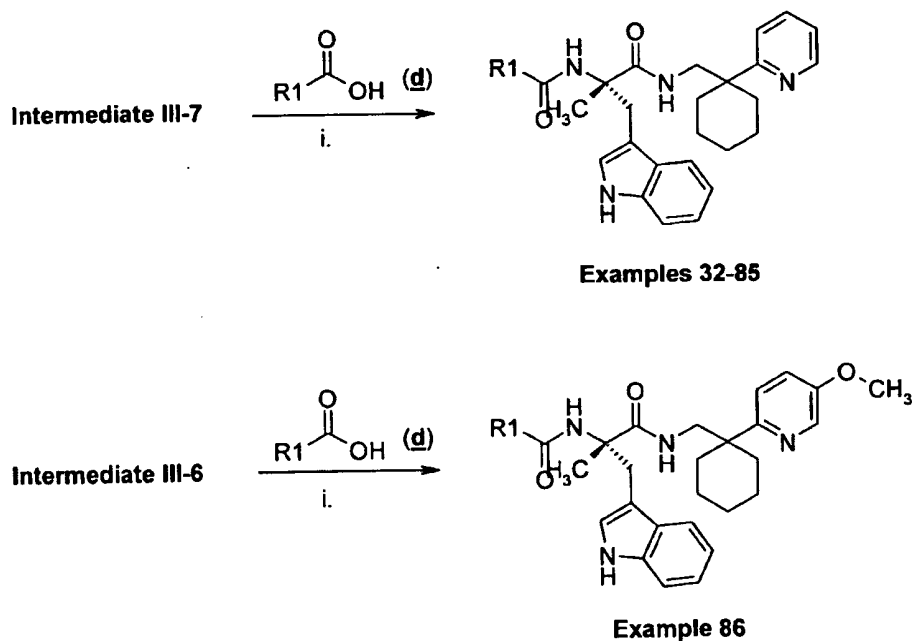
10

#### *N*-acyl derivatives of Intermediate III-6 and III-7

Scheme 8 describes the synthesis of *N*-acyl derivatives of Intermediates III-7 and III-6.

15

#### Scheme 8



i. HBTU, DIPEA, DMF

In scheme 8, R1 represents the rest of the carboxylic acid d molecule. These

20 intermediates d are listed in table 2.

**N-acyl derivatives of Intermediate III-7**

To acid d (0.18 mmol) was added 0.50 M HBTU in DMF (300  $\mu$ L, 0.15 mmol), 1.0 M diisopropylethylamine in DMF (300  $\mu$ L, 0.30 mmol) and 0.40 M Intermediate III-7 in DMF (375  $\mu$ L, 0.15 mmol). The solution was shaken on an orbital shaker at room temperature for 18 h. Water (1.0 mL) was added and the mixture was loaded onto a LC-18 SPE cartridge (0.5 g sorbent) and the cartridge was eluted with water (3 mL), 25% methanol/water (3 mL), 50% methanol/water (4 mL) and methanol (4.5 mL)). The methanol fraction was concentrated and analysed by LCMS. When the purity was <90% the product was further purified by prep. HPLC (column: Phenomenex primesphere 10  $\mu$  C18-HC 110A, 100x21.20 mm; mobile phase: methanol / water 10 to 100% gradient). The products were characterised and analysed by LCMS (column: 50x4.6 mm Prodigy ODSIII (5 $\mu$ ) column; mobile phase: acetonitrile / water (0.1% formic acid) 5 to 100% gradient over 2 min, held at 100% acetonitrile for 1 min; flow rate 4 mL/min; UV detection at 215 nm; mass spec: 150-900 Da full scan APCI+ centroid data)

The following products were made by the above method, with the starting material listed in Table 2 and gave the test results indicated in Table 3:

**TABLE 2**

Example	Intermediate <u>d</u>
32	Benzoic acid
33	4-Methyl-benzoic acid
34	4-Chloro-benzoic acid
35	4-Methoxy-benzoic acid
36	4-Nitro-benzoic acid
37	4-Methanesulfonyl-benzoic acid

38	3-Cyano-benzoic acid
39	3-Chloro-benzoic acid
40	3-Methoxy-benzoic acid
41	3-Methanesulfonyl-benzoic acid
42	3-Dimethylamino-benzoic acid
43	3-Methyl-benzoic acid
44	2-Chloro-benzoic acid
45	2-Nitro-benzoic acid
46	2-Methoxy-benzoic acid
47	2-Methyl-benzoic acid
48	2-Dimethylamino-benzoic acid
49	2-Fluoro-benzoic acid
50	<i>p</i> -Tolyl-acetic acid
51	<i>o</i> -Tolyl-acetic acid
52	(4-Hydroxy-phenyl)-acetic acid
53	(3-Hydroxy-phenyl)-acetic acid
54	<i>m</i> -Tolyl-acetic acid
55	(2-Fluoro-phenyl)-acetic acid
56	Thiophen-3-yl-acetic acid
57	Pyridine-2-carboxylic acid
58	Isonicotinic acid
59	Furan-3-carboxylic acid
60	Furan-2-carboxylic acid
61	1 <i>H</i> -Indole-2-carboxylic acid
62	5-Methyl-isoxazole-3-carboxylic acid
63	1-Methyl-1 <i>H</i> -pyrrole-2-carboxylic acid
64	Thiophene-2-carboxylic acid

65	Thiophene-3-carboxylic acid
66	1 <i>H</i> -Indole-6-carboxylic acid
67	1 <i>H</i> -Indole-5-carboxylic acid
68	1 <i>H</i> -Indole-4-carboxylic acid
69	1 <i>H</i> -Indole-7-carboxylic acid
70	1-Methyl-1 <i>H</i> -indole-2-carboxylic acid
71	Benzo[ <i>b</i> ]thiophene-2-carboxylic acid
72	Benzothiazole-6-carboxylic acid
73	1 <i>H</i> -Benzotriazole-5-carboxylic acid
74	3-Methyl-thiophene-2-carboxylic acid
75	5-Methyl-thiophene-2-carboxylic acid
76	6-Methyl-pyridine-2-carboxylic acid
77	Isoquinoline-3-carboxylic acid
78	Quinoxaline-2-carboxylic acid
79	Quinoline-8-carboxylic acid
80	5-Phenyl-oxazole-4-carboxylic acid
81	2-Pyrrol-1-yl-benzoic acid
82	(4-Methoxy-phenyl)-acetic acid
83	(4-Dimethylamino-phenyl)-acetic acid
84	(2-Nitro-phenyl)-acetic acid
85	(2-Methoxy-phenyl)-acetic acid
86	1 <i>H</i> -Indole-2-carboxylic acid

TABLE 3

Example No	Product	MH <sup>+</sup>	Purity %	LCMS Ret time (min)	BB1 IC50 (nM)	BB2 IC50 (nM)
32	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide	494,64	100	1.71	2499	IA
33	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-methyl-benzamide	508,67	95	1.76	2499	IA
34	4-Chloro-N-{(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexyl-methyl)-carbamoyl]-ethyl}-benzamide	529,09	94	1.84	1349	IA
35	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-methoxy-benzamide	524,67	94	1.68	2879	IA
36	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-nitro-benzamide	539,64	80	1.79	343	IA
37	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-methanesulfonyl-benzamide	572,73	95	1.60	2272	IA
38	3-Cyano-N-{(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide	519,65	91	1.71	2042	IA
39	3-Chloro-N-{(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexyl-methyl)-carbamoyl]-ethyl}-benzamide	529,09	97	1.84	1269	IA
40	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-3-methoxy-benzamide	524,67	98	1.73	2859	IA



41	N-((S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-3-methanesulfonyl-benzamide	572,73	95	1.60	3051	IA
42	Dimethylamino-N-((S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexyl-methyl)-carbamoyl]-ethyl)-benzamide	537,71	91	1.74	2518	IA
43	N-((S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-3-methyl-benzamide	508,67	100	1.79	2351	IA
44	2-Chloro-N-((S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexyl-methyl)-carbamoyl]-ethyl)-benzamide	529,09	98	1.79	3229	IA
45	N-((S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-2-nitro-benzamide	539,64	91	1.71	4581	IA
46	N-((S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-2-methoxy-benzamide	524,67	100	1.73	2559	IA
47	N-((S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-2-methyl-benzamide	508,67	100	1.79	3283	IA
48	C-Dimethylamino-N-((S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexyl-methyl)-carbamoyl]-ethyl)-benzamide	537,71	93	1.79	716	IA
49	2-Fluoro-N-((S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl)-benzamide	512,63	98	1.76	3949	IA
50	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-p-tolyl-ethanoylamino)-propionamide	522,70	94	1.76	944	IA
51	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-o-tolyl-ethanoylamino)-propionamide	522,70	98	1.76	944	IA

52	(S)-2-[2-(4-Hydroxy-phenyl)-ethanoylamino]-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	524,67	96	1.50	3135	IA
53	(S)-2-[2-(3-Hydroxy-phenyl)-ethanoylamino]-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	524,67	90	1.52	1437	IA
54	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-m-tolyl-ethanoylamino)-propionamide	522,70	95	1.76	817	IA
55	(S)-2-[2-(2-Fluoro-phenyl)-ethanoylamino]-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	526,66	94	1.71	878	1546
56	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-thiophen-3-yl-ethanoylamino)-propionamide	514,70	93	1.65	1437	IA
57	Pyridine-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	495,63	98	1.68	3709	IA
58	N-[(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-isonicotinamide	495,63	98	1.47	1365	IA
59	Furan-3-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	484,60	97	1.60	1204	IA
60	Furan-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	484,60	100	1.60	1204	IA
61	1H-Indole-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	533,68	100	1.79	289	527
62	5-Methyl-isoxazole-3-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	499,62	94	1.46	4127	IA

63	1-Methyl-1H-pyrrole-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	497,65	96	1.46	4819	-
64	Thiophene-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	500,67	100	1.42	1437	IA
65	Thiophene-3-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	500,67	100	1.39	2201	IA
66	1H-Indole-6-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	533,68	100	1.42	1604	IA
67	1H-Indole-5-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	533,68	100	1.35	1881	IA
68	1H-Indole-4-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	533,68	99	1.35	4503	IA
69	1H-Indole-7-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	533,68	100	1.60	1369	IA
70	1-Methyl-1H-indole-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	547,71	100	1.70	1233	IA
71	Benzo[b]thiophene-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	550,73	100	1.63	611	IA
72	Benzothiazole-6-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	551,72	95	1.35	897	1495
73	1H-Benzotriazole-5-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	535,65	95	1.25	3167	-

74	3-Methyl-thiophene-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	514,70	100	1.53	744	IA
75	5-Methyl-thiophene-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	514,70	100	1.60	1663	IA
76	6-Methyl-pyridine-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	509,66	98	1.6	2816	IA
77	Isoquinoline-3-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	545,69	100	1.71	1363	-
78	Quinoxaline-2-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	546,68	94	1.67	1425	IA
79	Quinoline-8-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	545,69	96	1.57	4479	IA
80	5-Phenyl-oxazole-4-carboxylic acid {(S)-2-(1H-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide	561,69	95	1.81	2660	IA
81	N-{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-pyrrol-1-yl-benzamide	559,72	98	1.71	361	IA
82	(S)-3-(1H-Indol-3-yl)-2-[2-(4-methoxy-phenyl)-ethanoylamino]-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	538,70	98	1.71	1694	IA
83	(S)-2-[2-(4-Dimethylamino-phenyl)-ethanoylamino]-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	551,74	100	1.36	2708	IA
84	(S)-3-(1H-Indol-3-yl)-2-methyl-2-[2-(2-nitro-phenyl)-ethanoylamino]-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	553,67	95	1.5	1979	IA

85	(S)-3-(1H-Indol-3-yl)-2-[2-(2-methoxy-phenyl)-ethanoylamino]-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	538,70	100	1.57	1326	2479
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IA: IC<sub>50</sub> > 10000 nM

### N-acyl derivative of Intermediate III-6

5

#### Example 86

**1H-Indole-2-carboxylic acid ((S)-2-(1H-indol-3-yl)-1-{{1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl}-carbamoyl}-1-methyl-ethyl)-amide**

10 To a solution of 1-*H*-Indole-2-carboxylic acid (38 mg, 0.24 mmol), **Intermediate III-6** (100 mg, 0.19 mmol) and diisopropylethylamine (61 mg, 0.47 mmol) in DMF (5 mL) was added HBTU (90 mg, 0.24 mmol). The reaction mixture was stirred at room temperature for 16 h. The reaction mixture was concentrated under reduced pressure and the residue was diluted with ethyl acetate, washed with brine, dried (MgSO<sub>4</sub>) and  
15 concentrated under reduced pressure. The residue was purified by column chromatography (60% ethyl acetate/heptane) to give **Example 86** as an amorphous white solid (65 mg, 61%).

IR (film): 3285, 2931, 2855, 1651, 1537, 1489, 1456, 1420, 1342, 1310, 1267, 1028, 908, 744 cm<sup>-1</sup>;

20 NMR (CDCl<sub>3</sub>): δ = 1.10-1.61 (11H, m), 1.95-2.04 (2H, m), 3.29-3.52 (4H, m), 3.43 (3H, s), 6.47 (1H, s), 6.86-6.90 (1H, m), 6.98-6.99 (2H, m), 7.09-7.42 (8H, m), 7.52-7.58 (2H, m), 7.73-7.74 (1H, m) 8.05 (1H, s), 9.11 (1H, s);

MS m/e (ES<sup>+</sup>): 564 (M<sup>+</sup> + H, 100%).

Binding studies of **Example 86** to the bombesin receptors gave the following results  
25 (IC<sub>50</sub>): BB1: 11 nM, BB2: 119 nM.

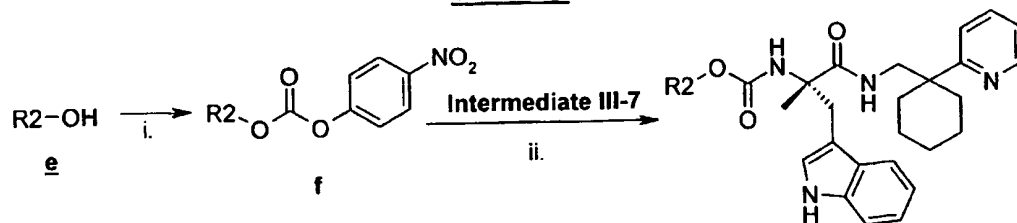
#### Examples 87-110

#### N-terminal urethane derivatives of Intermediate III-7

30

Scheme 9 describes the synthesis of urethane derivatives of **Intermediate III-7**:

- Conversion of alcohol into 4-nitrophenyl carbonates
- *N*-terminal urethane formation

**Scheme 9****Examples 87-110**

i. 4-nitrophenyl chloroformate, pyridine, THF

ii. DMAP, DMF

In scheme 9, R2 represents the rest of the intermediate **e**. These intermediates **e** are listed in table 4.

To a stirred solution of alcohol **e** (10 mmol) and 4-nitrophenyl chloroformate (2.01 g, 10 mmol) in dichloromethane (50 mL) at 0°C was added dropwise a solution of pyridine (0.81 mL, 10 mmol) in dichloromethane (10 mL). The reaction mixture was allowed to slowly warm to room temperature and was stirred at room temperature for 16 h. The solvent was removed under reduced pressure and the residue was taken up in ethyl acetate (50 mL) and was washed successively with 10% citric acid (2x30 mL), water (30 mL), sat. NaHCO<sub>3</sub> solution (2x50 mL) and brine (50 mL). The organic phase was dried (MgSO<sub>4</sub>) and was concentrated under reduced pressure. The crude product was recrystallised from typically ethyl acetate, diethyl ether or heptane to give pure carbonate **f**. The product was characterised by IR (see Table 4 for carbonate signals).

To carbonate **f** (0.21 mmol) was added DMF (0.4 mL) followed by 0.50 M DMAP in DMF (400 µL, 0.20 mmol) and 0.50 M **Intermediate III-7** in DMF (200 µL, 0.10 mmol). The solution was shaken on an orbital shaker at room temperature for 42 h. Water (1.0 mL) was added and the mixture was loaded onto a LC-18 SPE cartridge (0.5 g sorbent) and the cartridge was eluted with 25% methanol/water (3.4 mL) and methanol (4 mL). The methanol fraction was concentrated and purified by prep. HPLC (column: Phenomenex primesphere 10 µ C18-HC 110A, 100x21.20 mm; mobile phase: methanol/water 10 to

100% gradient). The products were characterised and analysed by LCMS (column: 50x4.6 mm Prodigy ODSIII (5 $\mu$ ) column; mobile phase: acetonitrile/water (0.1% formic acid) 5 to 100% gradient over 2 min, held at 100% acetonitrile for 1 min; flow rate 4 mL/min; UV detection at 215 nm; mass spec: 150-900 Da full scan APCI+ centroid data).

5

The following products were made by the above method, with the starting material listed in Table 4 and gave the test results indicated in Table 5:

TABLE 4

10

Example	intermediate e	intermediate f: IR (cm <sup>-1</sup> )
87	Naphthalen-1-yl-methanol	1754
88	(3,4-Dimethoxy-phenyl)-methanol	1754
89	Naphthalen-2-yl-methanol	1752
90	Indan-2-ol	1765
91	(3,4-Dichloro-phenyl)-methanol	1754
92	(4-Methoxy-phenyl)-methanol	1748
93	(4-Chloro-phenyl)-methanol	1761
94	(2-Fluoro-phenyl)-methanol	1752
95	(2-Chloro-phenyl)-methanol	1764
96	(4-Nitro-phenyl)-methanol	1761
97	<i>o</i> -Tolyl-methanol	1757
98	(4- <i>tert</i> -Butyl-phenyl)-methanol	1766
99	(3-Nitro-phenyl)-methanol	1769
100	(2-Methoxy-phenyl)-methanol	1766
101	(4-Trifluoromethyl-phenyl)-methanol	1763
102	(3-Ethoxy-phenyl)-methanol	1767
103	3-Hydroxymethyl-benzonitrile	1769
104	(2,4-Dichloro-phenyl)-methanol	1768
105	<i>m</i> -Tolyl-methanol	1757
106	(3-Phenoxy-phenyl)-methanol	1766

107	(3-Trifluoromethyl-phenyl)-methanol	1770
108	p-Tolyl-methanol	1759
109	(2,3-Dichloro-phenyl)-methanol	1758
110	Quinolin-6-yl-methanol	1761

TABLE 5

Examp le No	Product	MH <sup>+</sup>	Purity %	LCMS Ret time (min)	BB1 IC50 (nm)	BB2 IC50 (nm)
87	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid naphthalen-1-ylmethyl ester	574,73	100	1.67	239	IA
88	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid 3,4- dimethoxy-benzyl ester	584,72	95	1.41	1758	IA
89	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid naphthalen-2-ylmethyl ester	574,73	100	1.67	1001	IA
90	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid indan-2-yl ester	550,71	91	1.59	955	IA
91	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid 3,4- dichloro-benzyl ester	593,56	93	1.73	202	IA
92	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid 4- methoxy-benzyl ester	554,70	93	1.49	1610	IA
93	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1- [(1-pyridin-2-yl-cyclohexylmethyl)- carbamoyl]-ethyl}-carbamic acid 4- chloro-benzyl ester	559,11	98	1.62	681	IA

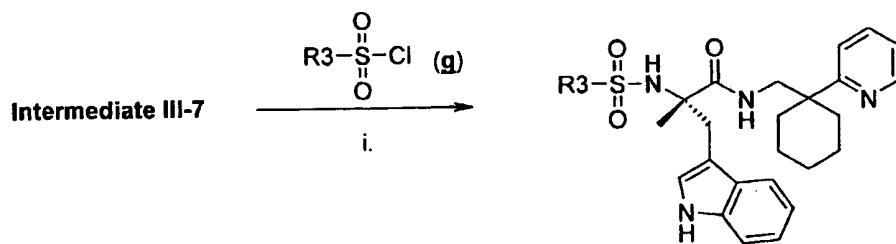


94	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2-fluoro-benzyl ester	542,66	91	1.52	923	IA
95	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2-chloro-benzyl ester	559,11	89	1.62	624	IA
96	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 4-nitro-benzyl ester	569,67	97	1.51	41	463
97	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2-methyl-benzyl ester	538,70	94	11.60	751	IA
98	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 4-tert-butyl-benzyl ester	580,78	100	1.86	1986	IA
99	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-nitro-benzyl ester	569,67	97	1.51	17	612
100	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2-methoxy-benzyl ester	554,70	96	1.52	818	IA
101	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 4-trifluoromethyl-benzyl ester	592,67	97	1.7	1102	IA
102	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-ethoxy-benzyl ester	568,72	89	1.60	1065	IA
103	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-cyano-benzyl ester	549,68	99	1.43	85	IA

104	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2,4-dichloro-benzyl ester	593,56	95	1.78	450	IA
105	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-methyl-benzyl ester	538,70	96	1.59	841	IA
106	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-phenoxy-benzyl ester	616,77	96	1.78	1350	IA
107	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-trifluoromethyl-benzyl ester	592,67	96	1.67	182	IA
108	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 4-methyl-benzyl ester	538,70	97	1.60	1084	IA
109	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 2,3-dichloro-benzyl ester	593,56	94	1.73	152	IA
110	{{(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid quinolin-6-ylmethyl ester	575,72	97	1.22	171	IA

## Examples 111-168

5

*N*-terminal sulfonamide derivatives of Intermediate III-7

Scheme 10

Examples 111-168

In scheme 10, R3 represents the rest of the intermediate g. These intermediates g are listed in table 6.

To sulfonyl chloride **g** (0.14 mmol) was added 0.143 M **Intermediate III-7** in  
5 DMF (700  $\mu$ L, 0.10 mmol) followed by 300  $\mu$ L of a solution containing a mixture of diisopropylethylamine (0.667 M in DMF, 0.20 mmol) and 4-dimethylaminopyridine (0.033 M in DMF, 0.01 mmol). The reaction mixture was shaken in an orbital shaker at 70°C for 16 h. The crude reaction mixture was loaded onto a 5 g silica cartridge and the cartridge was eluted with ethyl acetate in heptane (30 to 100% gradient). Removal  
10 of the solvent under reduced pressure gave the sulfonamides (**Examples 111-168**). The purity of the sulfonamide was checked by LCMS. Those samples that were less than 95% pure were further purified by prep HPLC (column: YMC-Pack ODS-AM, 5 $\mu$ m, 150x20 mm; mobile phase: acetonitrile / water 40 to 100% gradient). The products were characterised and analysed by LCMS (column: 150x4.6 mm Prodigy  
15 ODS3 (3 $\mu$ ) column; mobile phase: acetonitrile (0.085% TFA) / water (0.1% TFA) 20 to 100% gradient over 7 min, held at 100% acetonitrile (0.085% TFA) for 1 min; flow rate 1.5 mL/min; detection: diode array 200-300 nm; mass spec: 150-900 Da full scan APCI+ centroid data) (see Table 7).

20 The following examples were made by the above method, with the starting material listed in Table 6 and gave the test results indicated in Table 7:

TABLE 6

Example	intermediate g
111	Phenyl-methanesulfonyl chloride
112	4-Methyl-benzenesulfonyl chloride
113	2-Chloro-benzenesulfonyl chloride
114	2-Fluoro-benzenesulfonyl chloride
115	Naphthalene-1-sulfonyl chloride
116	4-Chloro-benzenesulfonyl chloride
117	5-Dimethylamino-naphthalene-1-sulfonyl chloride
118	Naphthalene-2-sulfonyl chloride
119	Thiophene-2-sulfonyl chloride
120	Quinoline-8-sulfonyl chloride
121	3-Nitro-benzenesulfonyl chloride
122	4-Fluoro-benzenesulfonyl chloride
123	4-Nitro-benzenesulfonyl chloride
124	3-Trifluoromethyl-benzenesulfonyl chloride
125	3,4-Dichloro-benzenesulfonyl chloride
126	3-Fluoro-benzenesulfonyl chloride
127	4-Trifluoromethyl-benzenesulfonyl chloride
128	5-Chloro-thiophene-2-sulfonyl chloride
129	2-Trifluoromethyl-benzenesulfonyl chloride
130	3-Chloro-benzenesulfonyl chloride
131	3-Methyl-benzenesulfonyl chloride
132	3,4-Dimethoxy-benzenesulfonyl chloride
133	4-Cyano-benzenesulfonyl chloride
134	2-Cyano-benzenesulfonyl chloride
135	5-Chloro-1,3-dimethyl-1 <i>H</i> -pyrazole-4-sulfonyl chloride
136	3,5-Dimethyl-isoxazole-4-sulfonyl chloride
137	Benzo[1,2,5]thiadiazole-4-sulfonyl chloride
138	1-Methyl-1 <i>H</i> -imidazole-4-sulfonyl chloride

139	Benzo[1,2,5]oxadiazole-4-sulfonyl chloride
140	3-Chlorosulfonyl-thiophene-2-carboxylic acid methyl ester
141	5-Isoxazol-3-yl-thiophene-2-sulfonyl chloride
142	(2-Nitro-phenyl)-methanesulfonyl chloride
143	3-Cyano-benzenesulfonyl chloride
144	1,2-Dimethyl-1 <i>H</i> -imidazole-4-sulfonyl chloride
145	3-Methoxy-benzenesulfonyl chloride
146	8-Nitro-naphthalene-1-sulfonyl chloride
147	2-Chloro-5-nitro-benzenesulfonyl chloride
148	2,4,6-Trichloro-benzenesulfonyl chloride
149	4-Chloro-2-nitro-benzenesulfonyl chloride
150	5-Benzenesulfonyl-thiophene-2-sulfonyl chloride
151	4-Trifluoromethoxy-benzenesulfonyl chloride
152	5-Methyl-2-phenoxy-benzenesulfonyl chloride
153	2- <i>p</i> -Tolyloxy-benzenesulfonyl chloride
154	Biphenyl-2-sulfonyl chloride
155	2-Chlorosulfonyl-benzoic acid methyl ester
156	3-Chloro-4-fluoro-benzenesulfonyl chloride
157	2,5-Dichloro-thiophene-3-sulfonyl chloride
158	3-Chloro-4-methyl-benzenesulfonyl chloride
159	2-Methoxy-4-methyl-benzenesulfonyl chloride
160	5-Pyridin-2-yl-thiophene-2-sulfonyl chloride
161	5-Bromo-6-chloro-pyridine-3-sulfonyl chloride
162	2,4-Dinitro-benzenesulfonyl chloride
163	4-Methanesulfonyl-benzenesulfonyl chloride
164	4- <i>tert</i> -Butyl-benzenesulfonyl chloride
165	2,4-Dichloro-5-methyl-benzenesulfonyl chloride
166	Chloro-trifluoromethyl-benzenesulfonyl chloride
167	Nitro-trifluoromethyl-benzenesulfonyl chloride
168	4-Butyl-benzenesulfonyl chloride

TABLE 7

Example No	Product	MH <sup>+</sup>	Purity %	LCMS Ret time (min)	BB1 IC50 (nm)	BB2 IC50 (nm)
111	(S)-3-(1H-Indol-3-yl)-2-methyl-2-phenylmethanesulfonylamino-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	544,72	100	4.64	186	IA
112	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(toluene-4-sulfonylamino)-propionamide	544,72	100	4.74	557	IA
113	(S)-2-(2-Chloro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	565,14	100	4.71	257	IA
114	(S)-2-(2-Fluoro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	548,68	100	4.54	267	IA
115	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(naphthalene-1-sulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	580,76	99	4.98	185	1576
116	(S)-2-(4-Chloro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	565,14	97	4.89	373	4386
117	(S)-2-(5-Dimethylamino-naphthalene-1-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	623,82	100	4.39	1302	IA
118	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(naphthalene-2-sulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	580,76	100	5.01	322	IA
119	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(thiophene-2-sulfonylamino)-propionamide	536,72	99	4.39	232	la

120	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(quinoline-8-sulfonylamino)-propionamide	581,74	99	4.53	108	IA
121	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(3-nitro-benzenesulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	575,69	99	4.58	208	1960
122	(S)-2-(4-Fluoro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	548,68	100	4.60	560	4165
123	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(4-nitro-benzenesulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	575,69	98	4.65	515	IA
124	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(3-trifluoromethyl-benzenesulfonylamino)-propionamide	599,58	100	5.03	440	2246
125	(S)-2-(3,4-Dichloro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	599,58	99	5.47	216	IA
126	(S)-2-(3-Fluoro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	548,68	100	4.65	407	2761
127	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(4-trifluoromethyl-benzenesulfonylamino)-propionamide	598,69	95	5.31	553	IA
128	(S)-2-(5-Chloro-thiophene-2-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	571,17	99	4.94	404	IA
129	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-trifluoromethyl-benzenesulfonylamino)-propionamide	598,69	99	5.11	134	-
130	(S)-2-(3-Chloro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	565,14	99	5.05	331	2687

131	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(toluene-3-sulfonylamino)-propionamide	544,72	99	4.93	393	1019
132	(S)-2-(3,4-Dimethoxy-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	590,75	98	4.50	608	IA
133	(S)-2-(4-Cyano-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	555,70	99	4.61	766	IA
134	(S)-2-(2-Cyano-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	555,70	97	4.62	408	IA
135	(S)-2-(5-Chloro-1,3-dimethyl-1H-pyrazole-4-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	583,16	98	4.38	1252	IA
136	(S)-2-(3,5-Dimethyl-isoxazole-4-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	549,70	96	4.54	515	IA
137	(S)-2-(Benzo[1,2,5]thiadiazole-4-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	588,76	97	4.67	256	IA
138	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(1-methyl-1H-imidazole-4-sulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	534,69	100	3.60	3667	IA
139	(S)-2-(Benzo[1,2,5]oxadiazole-4-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	572,69	100	4.70	507	IA
140	3-[(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethylsulfamoyl]-thiophene-2-carboxylic acid methyl ester	594,76	100	4.79	167	IA
141	(S)-3-(1H-Indol-3-yl)-2-(5-isoxazol-3-yl-thiophene-2-sulfonylamino)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	603,77	98	4.60	534	IA



142	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(2-nitro-phenylmethanesulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	589,72	100	4.65	430	IA
143	(S)-2-(3-Cyano-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	555,70	99	4.55	460	IA
144	(S)-2-(1,2-Dimethyl-1H-imidazole-4-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	548,71	96	3.55	2482	IA
145	(S)-3-(1H-Indol-3-yl)-2-(3-methoxy-benzenesulfonylamino)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	560,72	99	4.75	295	3686
146	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(8-nitro-naphthalene-1-sulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	625,75	99	4.89	177	IA
147	(S)-2-(2-Chloro-5-nitro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	610,14	96	5.00	374	Ia
148	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2,4,6-trichloro-benzenesulfonylamino)-propionamide	634,03	100	5.45	215	Ia
149	(S)-2-(4-Chloro-2-nitro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	610,14	100	5.13	513	IA
150	(S)-2-(5-Benzenesulfonyl-thiophene-2-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	676,88	100	5.03	297	IA
151	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(4-trifluoromethoxy-benzenesulfonylamino)-propionamide	614,69	99	5.35	635	IA
152	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(5-methyl-2-phenoxy-benzenesulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	636,82	97	5.79	76	IA

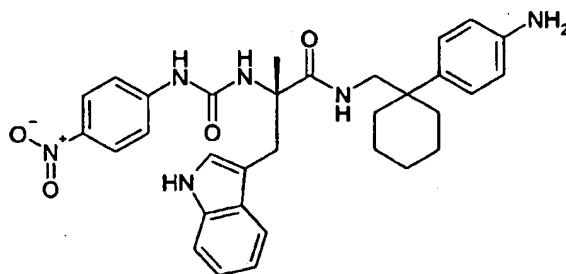
153	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-p-tolyloxy-benzenesulfonylamino)-propionamide	636,82	97	5.79	90	IA
154	(S)-2-(Biphenyl-2-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	606,79	97	5.52	166	IA
155	2-[(S)-2-(1H-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethylsulfamoyl]-benzoic acid methyl ester	588,73	99	4.84	242	IA
156	(S)-2-(3-Chloro-4-fluoro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	583,13	95	5.12	284	1216
157	(S)-2-(2,5-Dichloro-thiophene-3-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	605,61	99	5.23	214	IA
158	(S)-2-(3-Chloro-4-methyl-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	579,17	97	5.28	299	3939
159	(S)-3-(1H-Indol-3-yl)-2-(2-methoxy-4-methyl-benzenesulfonylamino)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	574,75	96	4.92	445	IA
160	(S)-3-(1H-Indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-2-(5-pyridin-2-yl-thiophene-2-sulfonylamino)-propionamide	613,81	100	4.79	344	IA
161	(S)-2-(5-Bromo-6-chloro-pyridine-3-sulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	645,02	95	5.09	187	IA
162	(S)-2-(2,4-Dinitro-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	620,69	100	4.97	475	IA
163	(S)-3-(1H-Indol-3-yl)-2-(4-methanesulfonyl-benzenesulfonylamino)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	608,78	98	4.20	1043	IA

164	(S)-2-(4-tert-Butyl-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	586,80	96	5.65	406	IA
165	(S)-2-(2,4-Dichloro-5-methyl-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	613,61	97	5.64	172	IA
166	(S)-2-(Chloro-trifluoromethyl-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	633,14	100	5.33	627	IA
167	(S)-3-(1H-Indol-3-yl)-2-methyl-2-(nitro-trifluoromethyl-benzenesulfonylamino)-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	643,69	100	5.34	758	IA
168	(S)-2-(4-Butyl-benzenesulfonylamino)-3-(1H-indol-3-yl)-2-methyl-N-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide	586,80	96	5.84	492	IA

### Example 169

- 5 **Bombesin antagonists potentiate pelvic nerve-stimulated increases in female genital blood flow in the anaesthetised rabbit model of sexual arousal.**

Bombesin antagonists used = Compound 1 and (2*S*)-*N*-{[1-(4-aminophenyl) cyclohexyl] methyl}-3-(1*H*-indol-3-yl)-2-methyl-2-[(4-nitroanilino) carbonyl] amino} propanamide (Compound 3).



hBB<sub>1</sub> Ki 0.25 nMhBB<sub>2</sub> Ki 46 nM

Female New Zealand rabbits (~2.5kg) were pre-medicated with a combination of Medetomidine (Domitor®) 0.5ml/kg *i.m.*, and Ketamine (Vetalar®) 0.25ml/kg *i.m.* whilst maintaining oxygen intake via a face mask. The rabbits were tracheotomised using a Portex™ uncuffed endotracheal tube 3 ID., connected to ventilator and maintained at a ventilation rate of 30-40 breaths per minute, with an approximate tidal volume of 18-20 ml, and a maximum airway pressure of 10 cm H<sub>2</sub>O. Anaesthesia was then switched to Isoflurane and ventilation continued with O<sub>2</sub> at 2l/min. The right marginal ear vein was cannulated using a 23G or 24G catheter, and Lactated Ringer solution perfused at 0.5ml/min. The rabbit was maintained at 3% Isoflurane during invasive surgery, dropping to 2% for maintenance anaesthesia.

The left groin area of the rabbit was shaved and a vertical incision was made approximately 5cm in length along the thigh. The femoral vein and artery were exposed, isolated and then cannulated with a PVC catheter (17G) for the infusion of drugs and compounds. Cannulation was repeated for the femoral artery, inserting the catheter to a depth of 10cm to ensure that the catheter reached the abdominal aorta. This arterial catheter was linked to a Gould system to record blood pressure. Samples for blood gas analysis were also taken via the arterial catheter. Systolic and diastolic pressures were measured, and the mean arterial pressure calculated using the formula (diastolic x2 + systolic) ÷3. Heart rate was measured via the pulse oxymeter and *Ponemah* data acquisition software system (Ponemah Physiology Platform, Gould Instrument Systems Inc). A ventral midline incision was made into the abdominal cavity. The incision was about 5cm in length just above the pubis. The fat and muscle was *bluntly* dissected away to reveal the hypogastric nerve which runs down the body cavity. It was essential to keep close to the side curve of the pubis wall in order to avoid damaging the femoral vein and artery which lie above the pubis. The sciatic and pelvic nerves lie deeper and were located after further dissection on the dorsal side of the rabbit. Once the sciatic nerve is identified, the pelvic nerve was easily located.

The term *pelvic nerve* is loosely applied; anatomy books on the subject fail to identify the nerves in sufficient detail. However, stimulation of the nerve causes an increase in vaginal and clitoral blood flow, and innervation of the pelvic region. The pelvic nerve was freed away from surrounding tissue and a *Harvard* bipolar stimulating electrode was placed around the nerve. The nerve was slightly lifted to give some tension, then the electrode was secured in position. Approximately 1ml of light paraffin oil was placed around the nerve and electrode. This acts as a protective lubricant to the nerve and prevents blood contamination of the electrode. The electrode was connected to a *Grass* S88 Stimulator. The pelvic nerve was stimulated using the following parameters:- 5V, pulse width 0.5ms, duration of stimulus 10 seconds and a frequency range of 2 to 16Hz. Reproducible responses were obtained when the nerve was stimulated every 15-20 minutes. A frequency response curve was determined at the start of each experiment in order to determine the optimum frequency to use as a sub-maximal response, normally 4Hz. A ventral midline incision was made, at the caudal end of the pubis, to expose the pubic area. Connective tissue was removed to expose the tunica of the clitoris, ensuring that the wall was free from small blood vessels. The external vaginal wall was also exposed by removing any connective tissue. One laser Doppler flow probe was inserted 3cm into the vagina, so that half the probe shaft was still visible. A second probe was positioned so that it lay just above the external clitoral wall. The position of these probes was then adjusted until a signal was obtained. A second probe was placed just above the surface of a blood vessel on the external vaginal wall. Both probes were clamped in position.

Compound 1 and compound 3 were dissolved in 50%  $\beta$ -cyclodextrin in saline. They were administered at a dose of 15mg/kg subcutaneously (sc). Vaginal and clitoral blood flow was recorded either as numbers directly from the Flowmeter using *Po-ne-mah* data acquisition software (Ponemah Physiology Platform, Gould Instrument Systems Inc), or indirectly from Gould chart recorder trace. Calibration was set at the beginning of the experiment (0-125ml/min/100g tissue). All data are reported as mean  $\pm$  s.e.m.. Significant changes were identified using Student's t-tests.

The non-selective BB1/BB2 bombesin receptor antagonist (Compound 1; 15mg/kg sc) acts as a potent enhancer of pelvic-nerve stimulated (PNS) increases in genital blood flow in the anaesthetised rabbit (Figure 22). Compound 1 had no effect on basal genital blood flow in the absence of PNS (Figure 22). This reinforces our view that antagonising/blocking BB1/BB2 receptors will enhance the arousal response by potentiating the central mechanism(s) that control sexual arousal/genital blood flow, and will not induce arousal in the absence of sexual stimulation.

The selective BB1 receptor antagonist (Compound 3; 15mg/kg sc) acts as a potent enhancer of pelvic-nerve stimulated (PNS) increases in vaginal and clitoral blood flow in the anaesthetised rabbit (Figure 23). The potentiation was significant 45mins after sc dosing and remained elevated for circa 1hr. Compound 3 had no effect on basal genital blood flow in the absence of PNS (Figure 23). This reinforces our view that a selective BB1 receptor antagonist will enhance the arousal response by potentiating the central mechanism(s) that control sexual arousal/genital blood flow, thereby treating FSAD, and will not induce arousal in the absence of sexual stimulation. Since these agents also enhance clitoral blood flow it is likely that they will be effective in the treatment of orgasmic disorders.

At the level of the genitalia, the enhancement observed is similar to the beneficial effects observed with apomorphine, and consequently we believe that a centrally mediated potentiation of the descending neuronal pathways that control genital blood flow is responsible.

**Example 170**

**Bombesin antagonists (compounds 1 and 3) induce increases in penile intracavernosal pressure in the conscious male rat.**

5

**Bombesin antagonists used = Compound 1 and (2S)-N-{{1-(4-aminophenyl) cyclohexyl} methyl}-3-(1H-indol-3-yl)-2-methyl-2-{{(4-nitroanilino) carbonyl} amino} propanamide (Compound 3).**

10 In addition to treating women with FSD, bombesin antagonists will be useful in treating male erectile dysfunction (MED. Both the non-selective BB1/2 antagonists (Compound 1; 10mg/kg sc) and the selective BB1 receptor antagonist (Compound 3; 15mg/kg sc) is pro-erectile in a conscious rat model of penile erection (Figures 24 and 25). Erectile responses were recorded by measuring intracavernosal pressure using  
15 surgically implanted telemetric device. The specific details the surgical procedures, data acquisition and analysis can be found in detail in Bernabe 1999.

Compound 1 and compound 3 were dissolved in 50%  $\beta$ -cyclodextrin in saline. They were administered at a dose of 15mg/kg subcutaneously (sc). One hour  
20 after 10mg/kg subcutaneous administration of Compound 1 and 45 minutes after a subcutaneous administration of 15mg/kg compound 3 one observes significant increases in intracavernosal pressure. These increases equate to penile erection. Both Compounds 1 and 3 induced a number of erections in a similar manner to those observed with apomorphine or melanotan-II - both of which are clinically proven  
25 agents that are effective in the treatment of MED. Moreover the amplitude of the increases observed were similar to those observed with apomorphine or melanotan-II. The mechanism of action is thought to be similar to the effects on female genital flow ie CNS potentiation of the descending neuronal pathways that control penile erection.

30

**Example 171**

**Concomitant administration of a Bombesin antagonists with a PDE5 inhibitor enhance pelvic nerve stimulated increases in penile intracavernosal pressure in an anaesthetised rabbit model of erection**

In addition to treating women with FSD, bombesin antagonists will be useful in treating male erectile dysfunction (MED) either alone or in combination with a selective PDE5 inhibitor.

10

Male New Zealand rabbits (~2.5kg) were pre-medicated with a combination of Medetomidine (Domitor®) 0.5ml/kg *i.m.*, and Ketamine (Vetalar®) 0.25ml/kg *i.m.* whilst maintaining oxygen intake via a face mask. The rabbits were tracheotomised using a Portex™ uncuffed endotracheal tube 3 ID., connected to ventilator and maintained at a ventilation rate of 30-40 breaths per minute, with an approximate tidal volume of 18-20 ml, and a maximum airway pressure of 10 cm H<sub>2</sub>O. Anaesthesia was then switched to Isoflurane and ventilation continued with O<sub>2</sub> at 2l/min. The right marginal ear vein was cannulated using a 23G or 24G catheter, and Lactated Ringer solution perfused at 0.5ml/min. The rabbit was maintained at 3% Isoflurane during invasive surgery, dropping to 2% for maintenance anaesthesia. The left jugular vein was exposed, isolated and then cannulated with a PVC catheter (17G) for the infusion of drugs and compounds.

The left groin area of the rabbit was shaved and a vertical incision was made approximately 5cm in length along the thigh. The femoral vein and artery were exposed, isolated and then cannulated with a PVC catheter (17G) for the infusion of drugs and compounds. Cannulation was repeated for the femoral artery, inserting the catheter to a depth of 10cm to ensure that the catheter reached the abdominal aorta. This arterial catheter was linked to a Gould system to record blood pressure. Samples for blood gas analysis were also taken via the arterial catheter. Systolic and diastolic pressures were measured, and the mean arterial pressure calculated using the formula



(diastolic  $\times 2$  + systolic)  $\div 3$ . Heart rate was measured via the pulse oxymeter and *Ponemah* data acquisition software system (Ponemah Physiology Platform, Gould Instrument Systems Inc).

5           A ventral midline incision was made into the abdominal cavity. The incision was about 5cm in length just above the pubis. The fat and muscle was *bluntly* dissected away to reveal the hypogastric nerve which runs down the body cavity. It was essential to keep close to the side curve of the pubis wall in order to avoid damaging the femoral vein and artery which lie above the pubis. The sciatic and  
10   pelvic nerves lie deeper and were located after further dissection on the dorsal side of the rabbit. Once the sciatic nerve is identified, the pelvic nerve was easily located. The term *pelvic nerve* is loosely applied; anatomy books on the subject fail to identify the nerves in sufficient detail. However, stimulation of the nerve causes an increase in intracavernosal pressure and cavernosal blood flow, and innervation of the pelvic  
15   region. The pelvic nerve was freed away from surrounding tissue and a *Harvard* bipolar stimulating electrode was placed around the nerve. The nerve was slightly lifted to give some tension, then the electrode was secured in position. Approximately 1ml of light paraffin oil was placed around the nerve and electrode. This acts as a protective lubricant to the nerve and prevents blood contamination of the electrode.  
20   The electrode was connected to a *Grass* S88 Stimulator. The pelvic nerve was stimulated using the following parameters:- 5V, pulse width 0.5ms, duration of stimulus 20 seconds with a frequency of 16Hz. Reproducible responses were obtained when the nerve was stimulated every 15-20 minutes. Several stimulations using the above parameters were performed to establish a mean control response. The  
25   compound(s) to be tested were infused, via the jugular vein, using a *Harvard* 22 infusion pump allowing a continuous 15 minute stimulation cycle. The skin and connective tissue around the penis was removed to expose the penis. A catheter set (*Insyte-W*, Becton-Dickinson 20 Gauge 1.1 x 48mm) was inserted through the tunica albica into the left *corpus cavernosal* space and the needle removed, leaving a flexible  
30   catheter. This catheter was linked via a pressure transducer (Ohmeda 5299-04) to a Gould system to record intracavernosal pressure. Once an intracavernosal pressure

was established, the catheter was sealed in place using *Vetbond* (tissue adhesive, 3M). Heart rate was measured via the pulse oxymeter and *Po-ne-mah* data acquisition software system (Ponemah Physiology Platform, Gould Instrument Systems Inc).

5            Intracavernosal blood flow was recorded either as numbers directly from the Flowmeter using *Po-ne-mah* data acquisition software (Ponemah Physiology Platform, Gould Instrument Systems Inc), or indirectly from Gould chart recorder trace. Calibration was set at the beginning of the experiment (0-125ml/min/100g tissue). All data are reported as mean  $\pm$  s.e.m.. Significant changes were identified  
10    using Student's t-tests.

Compound 1 and compound 3 were dissolved in 50%  $\beta$ -cyclodextrin in saline. They were administered at a dose of 15mg/kg subcutaneously (sc). Concomitant inhibition of BB1 receptors with compound 3 and PDE5 enzyme with a  
15    PDE5 inhibitor produced a marked enhancement of intracavernosal pressure, or the erectile process.

Figure 26 demonstrate that concomitant inhibition of Compound 3 (10mg/kg sc) and a selective inhibitor of PDE5 (3-ethyl-5-{5-[4-ethylpiperzino)sulphonyl-2-propoxyphenyl}-2-(2-pyridylmethyl)-6,7-dihydro-2H-pyrazolo[4,3-*d*]pyrimidin-7-one  
20    also known as 3-ethyl-5-{5-[4-ethylpiperzin-1-ylsulphonyl]-2-n-propoxyphenyl}-2-(2-pyridyl)methyl-2,6-dihydro-7H-pyrazolo[4,3-*d*]pyrimidin-7-one;            See WO98/491066; 1mg/kg iv) produced a marked enhancement of the ICP, or the erectile process, than was achievable with the same dose of the same Compound 3  
25    inhibitor alone. BB1 antagonists and PDE5 inhibitors or combinations of the two, have no significant effect on un-stimulated intracavernosal pressure ie they do not induce an increase in the absence of sexual drive/arousal. This data illustrates that there are a number of clinical benefits of concomitant administration of a PDE5 inhibitor and a bombesin antagonist over PDE5 inhibitor therapy alone. These include  
30    increased efficacy and opportunities to treat MED subgroups that do not respond to PDE5 inhibitor therapy.

**Test Assays: Auxiliary Compounds****NEP ENZYME ASSAY**

5

THE PREPARATION AND ASSAY OF SOLUBLE (NEP) NEUTRAL ENDOPEPTIDASE FROM CANINE, RAT, RABBIT AND HUMAN KIDNEY CORTEX.

- 10 Soluble NEP is obtained from the kidney cortex and activity is assayed by measuring the rate of cleavage of the NEP substrate Abz-D-Arg-Arg-Leu-EDDnp to generate its fluorescent product, Abz-D-Arg-Arg.

**EXPERIMENTAL PROCEDURE:-**

15

**1. MATERIALS****All water is double de ionised.****1.1 Tissues**

- 20 Human Kidney                      IIAM (Pennsylvania. U.S.A.)  
Rat Kidney  
Rabbit Kidney  
Canine Kidney

25 1.2 Homogenisation medium

100mM Mannitol and 20mM Tris @ pH 7.1

2.42g Tris (Fisher T/P630/60) is diluted in 1 litre of water and the pH adjusted to 7.1 using 6M HCl at room temperature. To this 18.22g Mannitol (Sigma M-9546) is added.

30

**1.3 Tris buffer (NEP buffer).**

50ml of 50mM Tris pH 7.4 (Sigma T2663) is diluted in 950ml of water.

#### 1.4 Substrate (Abz-D-Arg-Arg-Leu-EDDnp)

Made to order from SNPE, and is stored as a powder at  $-20^{\circ}\text{C}$ . A 2mM stock is made  
5 by gently re-suspending the substrate in Tris buffer, this should not be vortexed or  
sonicated. 600 $\mu\text{l}$  aliquots of the 2mM stock are stored at  $-20$  for up to one month.  
(Medeiros, M.A.S., Franca, M.S.F. et al., (1997), Brazilian Journal of Medical and  
Biological Research, 30, 1157-1162).

#### 10 1.5 Total product

Samples corresponding to 100% substrate to product conversion are included on the  
plate to enable the % substrate turnover to be determined. The total product is  
generated by incubating 1ml of 2mM substrate with 20 $\mu\text{l}$  of enzyme stock for 24  
hours at  $37^{\circ}\text{C}$ .

15

#### 1.6 Stop solution.

A 300 $\mu\text{M}$  stock of Phosphoramidon (Sigma R7385) is made up in NEP buffer and  
stored in 50 $\mu\text{l}$  aliquots at  $-20$ .

#### 20 1.7 Dimethyl sulphoxide (DMSO).

#### 1.8 Magnesium Chloride $-\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ (Fisher M0600/53).

#### 1.9 Black 96 well flat bottom assay plates (Costar 3915).

#### 1.10 Topseal A (Packard 6005185).

#### 1.11 Centrifuge tubes

25

### 2. SPECIFIC EQUIPMENT

#### 2.1 Sorvall RC-5B centrifuge (SS34 GSA rotor, pre-cooled to $4^{\circ}\text{C}$ ).

#### 2.2 Braun miniprimer mixer.

#### 2.3 Beckman CS-6R centrifuge.

#### 30 2.4 Fluostar galaxy.

#### 2.5 Wesbart 1589 shaking incubator.

### 3. METHODS

#### 3.1 TISSUE PREPARATION

3.2 Dog, rat, rabbit, and human NEP is obtained from the kidney cortex using a  
5 method adapted from Booth, A.G. & Kenny, A.J. (1974) *Biochem. J.* 142, 575-581.

3.3 Frozen kidneys are allowed to thaw at room temperature and the cortex is  
dissected away from the medulla.

3.4 The cortex is finely chopped and homogenised in approximately 10 volumes  
of homogenisation buffer (1.2) using a Braun miniprimer (2.2).

10 3.5 Magnesium chloride (1.8) (20.3mg/gm tissue) is added to the homogenate and  
stirred in an ice-water bath for 15 minutes.

3.6 The homogenate is centrifuged at 1,500g (3,820rpm) for 12 minutes in a  
Beckman centrifuge (2.3) before removing the supernatant to a fresh centrifuge tube  
and discarding the pellet.

15 3.7 The supernatant is centrifuged at 15,000g (12,100rpm) for 12 minutes in a  
Sovall centrifuge (2.1) and the supernatant is discarded.

3.8 The pale pink layer on the top of the remaining pellet is removed and re-  
suspended in homogenisation buffer containing magnesium chloride (9mg MgCl in  
5ml buffer per 1g tissue).

20 3.9 The suspension is centrifuged at 2,200g (4,630rpm) for 12 minutes in a  
Beckman centrifuge (2.3) before discarding the pellet.

3.10 The supernatant is centrifuged at 15,000g (12,100rpm) for 12 minutes using  
the Sorvall centrifuge (2.1) and the supernatant is discarded.

3.11 The final pellet is resuspended in homogenisation buffer containing  
25 magnesium chloride (0.9mg MgCl in 0.5ml buffer per 1g tissue). A homogenous  
suspension is obtained using a Braun miniprimer (2.2). This is then frozen down in  
100µl aliquots to be assayed for NEP activity.

#### 4.0 DETERMINATION OF NEP ACTIVITY

30

The activity of the previously aliquoted NEP is measured by its ability to cleave the

NEP specific peptide substrate.

- 4.1 A 4% DMSO/NEP buffer solution is made (4mls DMSO in 96mls NEP buffer).
- 5 4.2 Substrate, total product, enzyme, and Phosphoramidon stocks are left on ice to thaw.
- 4.3 50 $\mu$ l of 4% DMSO/NEP buffer solution is added to each well.
- 4.4 The 2mM substrate stock is diluted 1:40 to make a 50 $\mu$ M solution. 100 $\mu$ l of 50 $\mu$ M substrate is added to each well (final concentration 25 $\mu$ M).
- 10 4.5 50 $\mu$ l of a range of enzyme dilutions is added to initiate the reaction (usually 1:100, 1:200, 1:400, 1:800, 1:1600, and 1:3200 are used). 50 $\mu$ l of NEP buffer is added to blank wells.
- 4.6 The 2mM total product is diluted 1:80 to make a 25 $\mu$ M solution. 200 $\mu$ l of 25 $\mu$ M product is added to the first four wells of a new plate.
- 15 4.7 Plates are incubated at 37°C in a shaking incubator for 60 minutes.
- 4.8 The 300 $\mu$ M Phosphoramidon stock is diluted 1:100 to 300nM. The reaction is stopped by the addition of 100 $\mu$ l 300nM Phosphoramidon and incubated at 37°C in a shaking incubator for 20 minutes before being read on the Fluostar (ex320/em420).

## 20 5. NEP INHIBITION ASSAYS

- 5.1 Substrate, total product, enzyme and Phosphoramidon stocks are left on ice to thaw.
- 5.2 Compound stocks are made up in 100% DMSO and diluted 1:25 in NEP buffer to give a 4% DMSO solution. All further dilutions are carried out in a 4% DMSO solution (4mls DMSO in 96mls NEP buffer).
- 25 5.3 50 $\mu$ l of compound in duplicate is added to the 96 well plate and 50 $\mu$ l of 4% DMSO/NEP buffer is added to control and blank wells.
- 5.4 The 2mM substrate stock is diluted 1:40 in NEP buffer to make a 50 $\mu$ M solution (275 $\mu$ l 2mM substrate to 10.73ml buffer is enough for 1 plate).
- 30 5.5 The enzyme stock diluted in NEP buffer (determined from activity checks).

5.6 The 2mM total product stock is diluted 1:80 in NEP buffer to make a 25µM solution. 200µl is added to the first four wells of a separate plate.

5.7 The 300µM Phosphoramidon stock is diluted 1:1000 to make a 300nM stock (11µl Phosphoramidon to 10.99ml NEP buffer.

5 5.8 To each well in the 96 well plate the following is added:

Table Reagents to be added to 96 well plate.

	Compound/ DMSO	Tris Buffer	Substrate	NEP enzyme	Total product
Samples	2µl compound	50µl	100µl	50µl	None
Controls	2µl DMSO	50µl	100µl	50µl	None
Blanks	2µl DMSO	100µl	100µl	None	None
Totals	2µl DMSO	None	None	None	200µl

10 5.9 The reaction is initiated by the addition of the NEP enzyme before incubating at 37°C for 1 hour in a shaking incubator.

5.10 The reaction is stopped with 100µl 300nM Phosphoramidon and incubated at 37°C for 20 minutes in a shaking incubator before being read on the Fluostar (ex320/em420).

15

## 6. CALCULATIONS

The activity of the NEP enzyme is determined in the presence and absence of compound and expressed as a percentage.

20

% Control activity (turnover of enzyme):

$$\frac{\text{Mean FU of controls} - \text{Mean FU of blanks}}{\text{Mean FU of totals} - \text{Mean FU of blanks}} \times 100$$

25

% Activity with inhibitor:

$$\frac{\text{Mean FU of compound} - \text{Mean FU of blanks}}{\text{Mean FU of totals} - \text{Mean FU of blanks}} \times 100$$

5

Activity expressed as % of control:

$$\frac{\text{\% Activity with inhibitor}}{\text{\% Control activity}} \times 100$$

10

A sigmoidal dose-response curve is fitted to the % activities (% of control) vs compound concentration and IC50 values calculated using LabStats fit-curve in Excel.

#### ACE ASSAY

15

THE PREPARATION AND ASSAY OF SOLUBLE ANGIOTENSIN CONVERTING ENZYME (ACE), FROM PORCINE AND HUMAN KIDNEY CORTEX.

20 Soluble ACE activity is obtained from the kidney cortex and assayed by measuring the rate of cleavage of the ACE substrate Abz-Gly-p-nitro-Phe-Pro-OH to generate its fluorescent product, Abz-Gly.

#### 1. MATERIALS

25

All water is double de ionised.

- |     |              |  |
|-----|--------------|--|
| 1.1 | Human Kidney | IIAM (Pennsylvania. U.S.A.) or UK Human Tissue Bank (UK HTB) |
| 30  | 1.2          | Porcine kidney ACE   |
|     | 1.3          | Homogenisation buffer-1                                      |

Sigma (A2580)



100mM Mannitol and 20mM Tris @ pH 7.1

2.42g Tris (Fisher T/P630/60) is diluted in 1 litre of water and the pH adjusted to 7.1 using 6M HCl at room temperature. To this 18.22g Mannitol (Sigma M-9546) is added.

5    1.4    Homogenisation buffer-2

100mM Mannitol, 20mM Tris @ pH7.1 and 10mM  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  (Fisher M0600/53)

To 500ml of the homogenisation buffer 1 (1.4) 1.017g of  $\text{MgCl}_2$  is added.

1.5    Tris buffer (ACE buffer).

50mM Tris and 300mM NaCl @ pH 7.4

10    50ml of 50mM Tris pH 7.4 (Sigma T2663) and 17.52g NaCl (Fisher S/3160/60) are made up to 1000ml in water.

1.6    Substrate (Abz-D-Gly-p-nitro-Phe-Pro-OH) (Bachem M-1100)

ACE substrate is stored as a powder at  $-20^\circ\text{C}$ . A 2mM stock is made by gently re-suspending the substrate in ACE buffer, this must not be vortexed or sonicated. 400 $\mu\text{l}$

15    aliquots of the 2mM stock are stored at  $-20^\circ\text{C}$  for up to one month.

1.7    Total product

Samples corresponding to 100% substrate to product conversion are included on the plate to enable the % substrate turnover to be determined (see calculations). The total product is generated by incubating 1ml of 2mM substrate with 20 $\mu\text{l}$  of enzyme stock  
20    for 24 hours at  $37^\circ\text{C}$ .

1.8    Stop solution.

0.5M EDTA (Promega CAS[6081/92/6]) is diluted 1:250 in ACE buffer to make a 2mM solution.

1.9    Dimethyl sulphoxide (DMSO).

25    1.10    Magnesium Chloride - $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$  (Fisher M0600/53).

1.11    Black 96 well flat bottom assay plates (Costar 3915 or Packard).

1.12    Topseal A (Packard 6005185).

1.13    Centrifuge tubes

## 2. SPECIFIC EQUIPMENT

- 2.1 Sorvall RC-5B centrifuge (SS34 GSA rotor, pre-cooled to 4°C).
- 2.2 Braun miniprimer mixer.
- 5 2.3 Beckman CS-6R centrifuge.
- 2.4 BMG Fluostar Galaxy.
- 2.5 Wesbart 1589 shaking incubator.

## 3. METHODS

10

### 3.1 TISSUE PREPARATION

- 3.3 Human ACE is obtained from the kidney cortex using a method adapted from Booth, A.G. & Kenny, A.J. (1974) *Biochem. J.* 142, 575-581.
- 3.3 Frozen kidneys are allowed to thaw at room temperature and the cortex is  
15 dissected away from the medulla.
- 3.4 The cortex is finely chopped and homogenised in approximately 10 volumes of homogenisation buffer-1 (1.4) using a Braun miniprimer (2.2).
- 3.5 Magnesium chloride (1.11) (20.3mg/gm tissue) is added to the homogenate and stirred in an ice-water bath for 15 minutes.
- 20 3.6 The homogenate is centrifuged at 1,500g (3,820rpm) for 12 minutes in a Beckman centrifuge (2.3) before removing the supernatant to a fresh centrifuge tube and discarding the pellet.
- 3.7 The supernatant is centrifuged at 15,000g (12,100rpm) for 12 minutes in a Sovall centrifuge (2.1) and the supernatant is discarded.
- 25 3.8 The pale pink layer on the top of the remaining pellet is removed and re-suspended in homogenisation buffer-2 (1.5) (5ml buffer per 1g tissue).
- 3.9 The suspension is centrifuged at 2,200g (4,630rpm) for 12 minutes in a Beckman centrifuge before discarding the pellet.
- 3.10 The supernatant is centrifuged at 15,000g (12,100rpm) for 12 minutes using  
30 the Sorvall centrifuge and the supernatant is discarded.

3.11 The final pellet is resuspended in homogenisation buffer-2 (0.5ml buffer per 1g tissue). A homogenous suspension is obtained using a Braun miniprimer. This is then frozen down in 100µl aliquots to be assayed for NEP activity.

## 5 4.0 DETERMINATION OF ACE ACTIVITY

The activity of the previously aliquoted ACE is measured by its ability to cleave the ACE specific peptide substrate.

Porcine ACE (1.2) is defrosted and resuspended in ACE buffer (1.6) at 0.004U/µl, this is frozen down in 50µl aliquots.

4.1 A 4% DMSO/ACE buffer solution is made (4mls DMSO in 96mls ACE buffer).

4.2 Substrate (1.7), total product (1.8) and enzyme (1.1, 1.2, 1.3), are left on ice to thaw.

4.3 50µl of 4% DMSO/ACE buffer solution is added to each well.

4.4 The 2mM substrate stock is diluted 1:100 to make a 20µM solution. 100µl of 20µM substrate is added to each well (final concentration in the assay 10µM).

4.5 50µl of a range of enzyme dilutions is added to initiate the reaction (usually 1:100, 1:200, 1:400, 1:800, 1:1600, and 1:3200 are used). 50µl of ACE buffer is added to blank wells.

4.6 The 2mM total product is diluted 1:200 to make 10µM solution. 200µl 10µM product is added to the first four wells of a new plate.

4.7 Plates are incubated at 37°C in a shaking incubator for 60 minutes.

4.8 The enzyme reaction is stopped by the addition of 100µl 2mM EDTA in ACE buffer and incubated at 37°C in a shaking incubator for 20 minutes before being read on the BMG Fluostar Galaxy (ex320/em420).

## 5. ACE INHIBITION ASSAYS

5.1 Substrate, total product, and enzyme stocks are left on ice to thaw.

5.2 Compound stocks are made up in 100% DMSO and diluted 1:25 in ACE buffer to give a 4% DMSO solution. All further dilutions are carried out in a 4% DMSO/ACE buffer solution (4mls DMSO in 96mls ACE buffer).

5.3 50µl of compound, in duplicate, is added to the 96 well plate and 50µl of 4% DMSO/ACE buffer is added to control and blank wells.

5.4 Steps 5.2 and 5.3 can be carried out either by hand or using the Packard multiprobe robots

5.5 The 2mM substrate stock is diluted 1:100 in ACE buffer to make a 20µM solution (10µM final concentration in the assay) (110µl of 2mM substrate added to 10.89ml buffer is enough for 1 plate).

5.6 The enzyme stock is diluted in ACE buffer, as determined from activity checks (4.0).

5.7 The 2mM total product stock is diluted 1:200 in ACE buffer to make a 10µM solution. 200µl is added to the first four wells of a separate plate.

5.8 The 0.5mM EDTA stock is diluted 1:250 to make a 2mM stock (44µl EDTA to 10.96ml ACE buffer).

5.9 To each well of the 96 well plate the following reagents are added:

Table 1: Reagents added to 96 well plate.

	Compound/ DMSO	Tris Buffer	Substrate	ACE enzyme	Total product
Samples	2µl compound	50µl	100µl	50µl	None
Controls	2µl DMSO	50µl	100µl	50µl	None
Blanks	2µl DMSO	100µl	100µl	None	None
Totals	2µl DMSO	None	None	None	200µl

5.10 50µl of the highest concentration of each compound used in the assay is added in duplicate to the same 96 well plate as the totals (5.7). 150µl of ACE buffer is added to determine any compound fluorescence.

5.11 The reaction is initiated by the addition of the ACE enzyme before incubating at 37°C for 1 hour in a shaking incubator.

5.12 The reaction is stopped by the addition of 100µl 2mM EDTA and incubated at 37°C for 20 minutes in a shaking incubator, before being read on the BMG Fluostar

5 Galaxy (ex320/em420).

## 6. CALCULATIONS

10 The activity of the ACE enzyme is determined in the presence and absence of compound and expressed as a percentage.

FU = Fluorescence units

(i) % Control activity (turnover of enzyme):

15

$$\frac{\text{Mean FU of controls} - \text{Mean FU of blanks}}{\text{Mean FU of totals} - \text{Mean FU of blanks}} \times 100$$

20 (ii) % Activity with inhibitor:

$$\frac{\text{Mean FU of compound} - \text{Mean FU of blanks}}{\text{Mean FU of totals} - \text{Mean FU of blanks}} \times 100$$

25 (iii) Activity expressed as % of control:

$$\frac{\text{Mean FU of compound} - \text{Mean FU of blanks}}{\text{Mean FU of controls} - \text{Mean FU of blanks}} \times 100$$

30

OR 
$$\frac{\text{Mean FU of compound} - \text{Mean FU of blanks}}{\text{Mean FU of controls} - \text{Mean FU of blanks}} \times 100$$

(iv) % Inhibition = 100 - % control

5 (v) For fluorescent compounds the mean FU of blanks containing compound (5.10) is deducted from the mean FU of compound values used to calculate the % Activity.

A sigmoidal dose-response curve is fitted to the % activities (% of control) vs compound concentration and IC<sub>50</sub> values calculated using LabStats fit-curve in Excel.

10

### **PDE5 inhibitor – TEST METHODS**

#### **Phosphodiesterase (PDE) inhibitory activity**

15 In vitro PDE inhibitory activities against cyclic guanosine 3',5'-monophosphate (cGMP) and cyclic adenosine 3',5'-monophosphate (cAMP) phosphodiesterases were determined by measurement of their IC<sub>50</sub> values (the concentration of compound required for 50% inhibition of enzyme activity).

20 The required PDE enzymes were isolated from a variety of sources, including human corpus cavernosum, human and rabbit platelets, human cardiac ventricle, human skeletal muscle and human and canine retina, essentially by the method of W.J. Thompson and M.M. Appleman (Biochem., 1971, 10, 311). In particular, the cGMP-specific PDE (PDE5) and the cGMP-inhibited cAMP PDE (PDE3) were  
25 obtained from human corpus cavernosum or human platelets; the cGMP-stimulated PDE (PDE2) was obtained from human corpus cavernosum and human platelets; the calcium/calmodulin (Ca/CAM)-dependent PDE (PDE1) from human cardiac ventricle; the cAMP-specific PDE (PDE4) from human skeletal muscle and human recombinant, expressed in SF9 cells; and the photoreceptor PDE (PDE6) from human  
30 or canine retina. Phosphodiesterases 7-11 were generated from full length human recombinant clones transfected into SF9 cells.

Assays can be performed either using a modification of the "batch" method of W.J. Thompson *et al.* (Biochem., 1979, 18, 5228) or using a scintillation proximity assay for the direct detection of AMP/GMP using a modification of the protocol described by Amersham plc under product code TRKQ7090/7100. In summary, the effect of PDE inhibitors was investigated by assaying a fixed amount of enzyme in the presence of varying inhibitor concentrations and low substrate, (cGMP or cAMP in a 3:1 ratio unlabelled to [<sup>3</sup>H]-labeled at a conc ~1/3  $K_m$ ) such that  $IC_{50} \cong K_i$ . The final assay volume was made up to 100µl with assay buffer [20 mM Tris-HCl pH 7.4, 5 mM MgCl<sub>2</sub>, 1 mg/ml bovine serum albumin]. Reactions were initiated with enzyme, incubated for 30-60 min at 30°C to give <30% substrate turnover and terminated with 50 µl yttrium silicate SPA beads (containing 3 mM of the respective unlabelled cyclic nucleotide for PDEs 9 and 11). Plates were re-sealed and shaken for 20 min, after which the beads were allowed to settle for 30 min in the dark and then counted on a TopCount plate reader (Packard, Meriden, CT) Radioactivity units were converted to % activity of an uninhibited control (100%), plotted against inhibitor concentration and inhibitor  $IC_{50}$  values obtained using the 'Fit Curve' Microsoft Excel extension (or in-house equivalent). Results from these tests show that the compounds of the present invention are inhibitors of cGMP-specific PDE5.

#### Functional activity

This can be assessed *in vitro* by determining the capacity of a compound of the invention to enhance sodium nitroprusside or electrical field stimulation-induced relaxation of pre-contracted rabbit corpus cavernosum tissue strips, using methods based on that described by S.A. Ballard *et al.* (Brit. J. Pharmacol., 1996, 118 (suppl.), abstract 153P) or S.A. Ballard *et al.* (J. Urology, 1998, 159, 2164-2171).

#### In vivo activity

Compounds can be screened in anaesthetised dogs to determine their capacity, after i.v. administration, to enhance the pressure rises in the corpora cavernosa of the penis

induced by intracavernosal injection of sodium nitroprusside, using a method based on that described by Trigo-Rocha *et al.* (Neurourol. and Urodyn., 1994, 13, 71).

**NPY assay:**

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An assay for identifying NPY inhibitors is presented in WO-A-98/52890 (see page 96, lines 2 to 28).

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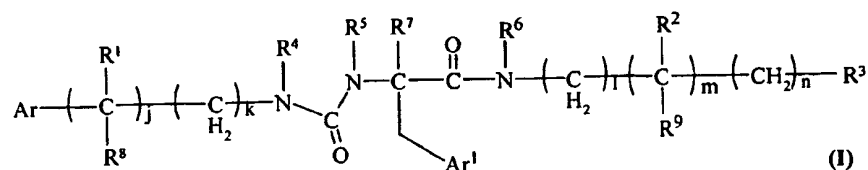
## CLAIMS

1. A pharmaceutical combination (for simultaneous, separate or sequential administration) of a bombesin receptor antagonist and one or more materials selected
- 5 from (1) to (34) below:
- (1) naturally occurring or synthetic prostaglandins or esters thereof;
  - (2)  $\alpha$  - adrenergic receptor antagonist compounds also known as  $\alpha$  - adrenoceptor antagonists or  $\alpha$ -receptor antagonists or  $\alpha$ -blockers;
  - (3) NO-donor (NO-agonist) compounds;
  - 10 (4) potassium channel openers or modulators;
  - (5) dopaminergic agents;
  - (6) vasodilator agents;
  - (7) thromboxane A2 agonists;
  - (8) CNS active agents;
  - 15 (9) ergot alkaloids;
  - (10) compounds which modulate the action of natriuretic factors;
  - (11) angiotensin receptor antagonists such as losartan.;
  - (12) substrates for NO-synthase;
  - (13) calcium channel blockers;
  - 20 (14) cholesterol lowering agents;
  - (15) antiplatelet and antithrombotic agents;
  - (16) insulin sensitising agents and hypoglycaemic agents;
  - (17) L-DOPA or carbidopa;
  - (18) acetylcholinesterase inhibitors;
  - 25 (19) steroidal or non-steroidal anti-inflammatory agents;
  - (20) estrogen receptor modulators and/or estrogen agonists and/or estrogen antagonists, and pharmaceutically acceptable salts thereof;
  - (21) PDE inhibitors;
  - (22) NPY (neuropeptide Y) inhibitors;
  - 30 (23) NEP inhibitors;

- (24) vasoactive intestinal proteins (VIP), VIP mimetics, VIP analogues, VIP receptor agonists or VIP analogues or VIP fragments, or  $\alpha$ -adrenoceptor antagonists with VIP combinations;
- (25) melanocortin receptor agonists or modulators or melanocortin enhancers;
- (26) serotonin receptor agonists, antagonists or modulators;
- (27) testosterone replacement agents, testosterone, dihydrotestosterone or a testosterone implant;
- (28) estrogen, estrogen and medroxyprogesterone or medroxyprogesterone acetate (MPA) (i.e. as a combination), or estrogen and methyl testosterone hormone replacement therapy agents;
- (29) modulators of transporters for noradrenaline, dopamine and/or serotonin;
- (30) purinergic receptor agonists and/or modulators;
- (31) neurokinin (NK) receptor antagonists;
- (32) opioid receptor agonists, antagonists or modulators;
- (33) agonists or modulators for oxytocin/vasopressin receptors; and
- (34) modulators of cannabinoid receptors.
2. The combination of claim 1, wherein the bombesin receptor antagonist is a selective bombesin BB<sub>1</sub> antagonist.
3. The combination of claim 2, wherein the bombesin BB<sub>1</sub> antagonist has a selectivity for BB<sub>1</sub> over the other bombesin receptor subtypes greater than 10.
4. The combination of claim 2, wherein the bombesin BB<sub>1</sub> antagonist has a selectivity for BB<sub>1</sub> over the other bombesin receptor subtypes greater than 30.
5. The combination of claim 2, wherein the bombesin BB<sub>1</sub> antagonist has a selectivity for BB<sub>1</sub> over the other bombesin receptor subtypes greater than 100.

6. The combination of claim 1, wherein the bombesin receptor antagonist is a mixed BB1/BB2 antagonist.
7. The combination of any preceding claim, wherein the bombesin receptor antagonist has a  $K_i$  against BB1 of less than 1000nM.
8. The combination of any of claims 1-6, wherein the bombesin receptor antagonist has a  $K_i$  against BB1 of less than 500nM.
9. The combination of any of claims 1-6, wherein the bombesin receptor antagonist has a  $K_i$  against BB1 of less than 100nM.
10. The combination of any of claims 1-6, wherein the bombesin receptor antagonist has a  $K_i$  against BB1 of less than 50nM.
11. The combination of any of claims 1-6, wherein the bombesin receptor antagonist has a  $K_i$  against BB1 of less than 10nM.
12. The combination of any preceding claim, comprising an effective amount of a non-peptide bombesin receptor antagonist.
13. The combination of any of claims 1-11, wherein there is administered to the subject an effective amount of a bombesin receptor antagonist which is a peptide
14. The combination of any preceding claim, wherein the non-peptide bombesin receptor antagonist is a compound that is absorbable when administered orally.
15. The combination of any preceding claim, wherein the bombesin receptor antagonist is a compound of the formula (I)

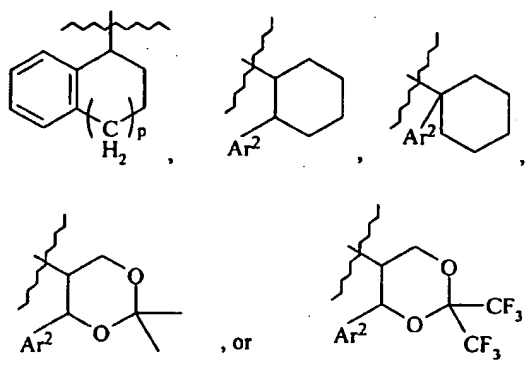
172



or a pharmaceutically acceptable salt thereof, wherein:

- j is 0 or 1;
- k is 0 or 1;
- 5    • l is 0, 1, 2, or 3;
- m is 0 or 1;
- n is 0, 1 or 2;
- Ar is phenyl, pyridyl or pyrimidyl, each unsubstituted or substituted by from 1 to 3 substituents selected from alkyl, halogen, alkoxy, acetyl, nitro, amino, -CH<sub>2</sub>NR<sup>10</sup>R<sup>11</sup>, cyano, -CF<sub>3</sub>, -NHCONH<sub>2</sub>, and -CO<sub>2</sub>R<sup>12</sup>;
- 10   • R<sup>1</sup> is hydrogen or straight, branched, or cyclic alkyl of from 1 to 7 carbon atoms;
- R<sup>8</sup> is hydrogen or forms a ring with R<sup>1</sup> of from 3 to 7 carbon atoms;
- R<sup>2</sup> is hydrogen or straight, branched, or cyclic alkyl of from 1 to 8 carbon atoms which can also contain 1 to 2 oxygen or nitrogen atoms;
- 15   • R<sup>9</sup> is hydrogen or forms with R<sup>2</sup> a ring of from 3 to 7 carbon atoms which can contain an oxygen or nitrogen atom; or R<sup>2</sup> and R<sup>9</sup> can together be a carbonyl;
- Ar<sup>1</sup> can be independently selected from Ar and can also include pyridyl-N-oxide, indolyl, imidazolyl, and pyridyl;
- 20   • R<sup>4</sup>, R<sup>5</sup>, R<sup>6</sup>, and R<sup>7</sup> are each independently selected from hydrogen and lower alkyl; R<sup>4</sup> can also form with R<sup>5</sup> a covalent link of 2 to 3 atoms which may include an oxygen or a nitrogen atom;
- R<sup>3</sup> can be independently selected from Ar or is hydrogen, hydroxy, -NMe<sub>2</sub>, N-methyl-pyrrolyl, imidazolyl, N-methyl-imidazolyl, tetrazolyl, N-methyl-tetrazolyl, thiazolyl, -CONR<sup>13</sup>R<sup>14</sup>, alkoxy,
- 25

173

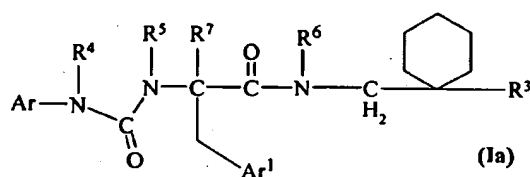


wherein p is 0, 1 or 2 and Ar<sup>2</sup> is phenyl or pyridyl;

- R<sup>10</sup>, R<sup>11</sup>, R<sup>12</sup>, R<sup>13</sup> and R<sup>14</sup> are each independently selected from hydrogen or straight, branched, or cyclic alkyl of from 1 to 7 carbon atoms.

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16. The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound of Formula (Ia)



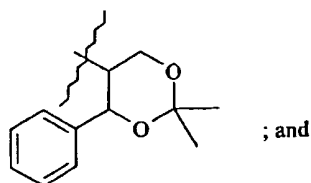
wherein

- 10 • Ar is phenyl unsubstituted or substituted with 1 or 2 substituents selected from isopropyl, halo, nitro, and cyano;
- R<sup>4</sup>, R<sup>5</sup>, and R<sup>6</sup> are hydrogen;
- R<sup>7</sup> is methyl or hydrogen;
- R<sup>3</sup> is 2-pyridyl or hydroxy; and
- 15 • Ar<sup>1</sup> is indolyl, pyridyl, pyridyl-N-oxide, or imidazolyl.

17. The combination of claim 15, wherein the bombesin receptor antagonist is a compound of Formula I wherein

- Ar is unsubstituted phenyl;
- 20 • R<sup>1</sup> is cyclopentyl or *tert*-butyl;
- R<sup>4</sup> and R<sup>5</sup> are hydrogen;

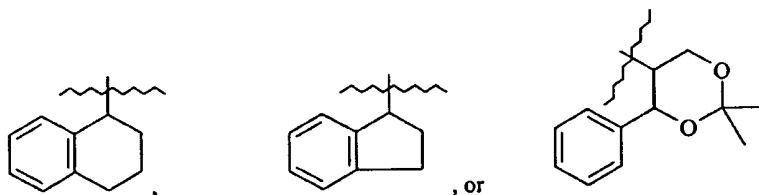
- R<sup>7</sup> is methyl;
- R<sup>6</sup> is hydrogen;
- R<sup>3</sup> is phenyl with two isopropyl substituents, unsubstituted phenyl, or



5 Ar<sup>1</sup> is indolyl.

18. The combination of claim 15, wherein the bombesin receptor antagonist is a compound of Formula I wherein

- Ar is 2,6-diisopropyl-phenyl, 4-nitro-phenyl, and 4-cyano-phenyl;
- 10 • R<sup>4</sup>, R<sup>5</sup>, and R<sup>6</sup> are hydrogen;
- R<sup>7</sup> is methyl;
- R<sup>2</sup> is hydrogen or cyclohexyl; and
- R<sup>3</sup> is hydroxyl, pyridyl,



15

19. The combination of claim 1, wherein the bombesin receptor antagonist is (S)-3-(1H-Indol-3-yl)-N-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propanamide (also referred to as Compound 1)

20 or one of its pharmaceutically acceptable salts or is

(2S)-N-[[1-(4-aminophenyl) cyclohexyl] methyl]-3-(1H-indol-3-yl)-2-methyl-2-[[{(4-nitroanilino) carbonyl] amino} propanamide (also known as Compound 3) or one of its pharmaceutically acceptable salts.



20. The combination of claim 1, wherein the bombesin receptor antagonist is a compound set out below or a pharmaceutically acceptable salt thereof:

(S) *N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

5 *N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-*N*-methyl-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-1-methyl-ureido]-3-(1*H*-indol-3-yl)-propionamide;

10 2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-(1-oxy-pyridin-2-yl)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-pyridin-2-yl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

2-[3-(2-*tert*-butyl-phenyl)-ureido]-*N*-cyclohexylmethyl-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

15 *N*-cyclohexylmethyl-2-[3-(2,6-dichloro-phenyl)ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,6-dimethoxy-phenyl)ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

20 *N*-cyclohexylmethyl-2-[3-(2,6-dimethylamino-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

(S) *N*-cyclohexylmethyl-3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide;

*N*-cyclohexylmethyl-2-[3-(2,2-dimethyl-1-phenyl)propyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

25 [S-(R\*, R\*)] 3-(1*H*-indol-3-yl)-2-methyl-2-{3-[1-(4-nitro-phenyl)-ethyl]-ureido}-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

*N*-(2,2-dimethyl-4-phenyl-[1,3]dioxan-5-yl)-3-(1*H*-indol-3-yl)-2-methyl-2-[3-(1-phenyl-cyclopentylmethyl)ureido]-propionamide;

30 (S)-*N*-(2,6-diisopropyl-phenyl)-2-[3-(2,2-dimethyl-1-phenyl-propyl)-ureido]-3-(1*H*-indol-3-yl)-propionamide;

(R)-*N*-(2,6-diisopropyl-phenyl)-2-[3-(2,2-dimethyl-1-phenyl-propyl)-ureido]-3-(1*H*-indol-3-yl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-(2,2-dimethyl-4-phenyl-[1,3]dioxan-5-yl)-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

5 *N*-cyclohexyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

*N*-(2-cyclohexyl-ethyl)-2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(3-methyl-butyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(3-phenyl-propyl)-propionamide;

15 2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1,2,3,4-tetrahydro-naphthalen-1-yl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(2-phenyl-cyclohexyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-indan-1-yl-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-*N*-(1-hydroxy-cyclohexylmethyl)-3-(1*H*-indol-3-yl)-2-methyl-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

25 2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(6,7,8,9-tetrahydro-5*H*-benzocyclohepten-5-yl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-phenyl-propionamide;

30 *N*-(1-hydroxy-cyclohexylmethyl)-3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide;

2-[3-(4-cyano-phenyl)-ureido]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(*S*) 3-(1*H*-indol-3-yl)-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

5 (*S*) 3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-[3-(4-trifluoromethyl-phenyl)-ureido]-propionamide;

(*S*) 4-{3-[2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-ureido)-benzoic acid ethyl ester;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-3-(1*H*-imidazol-4-yl)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

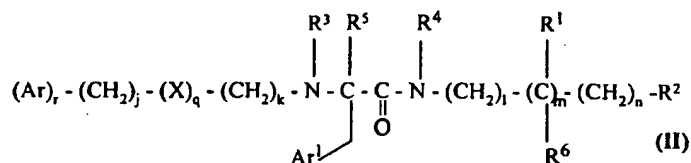
2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-3-(2-trifluoromethyl-phenyl)-propionamide;

2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-(2-nitro-phenyl)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

15 (*S*) 3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[3-(4-nitro-phenyl)-ureido]-propionamide; and

*N*-cyclohexylmethyl-2-[3-(2,6-diisopropyl-phenyl)-ureido]-2-methyl-3-pyridin-2-yl-propionamide.

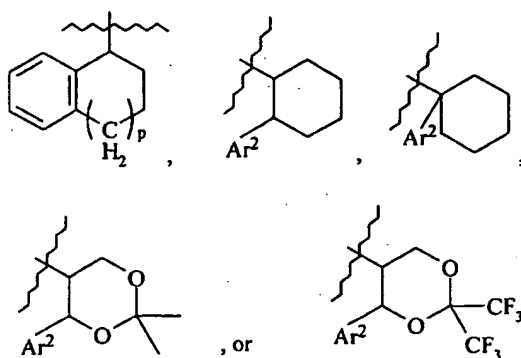
20 21. The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound of formula (II) or a pharmaceutically acceptable salt thereof:



25 wherein:

- *j* is 0, 1 or 2;
- *k* is 0 or 1;
- *l* is 0, 1, 2, or 3;
- *m* is 0 or 1;

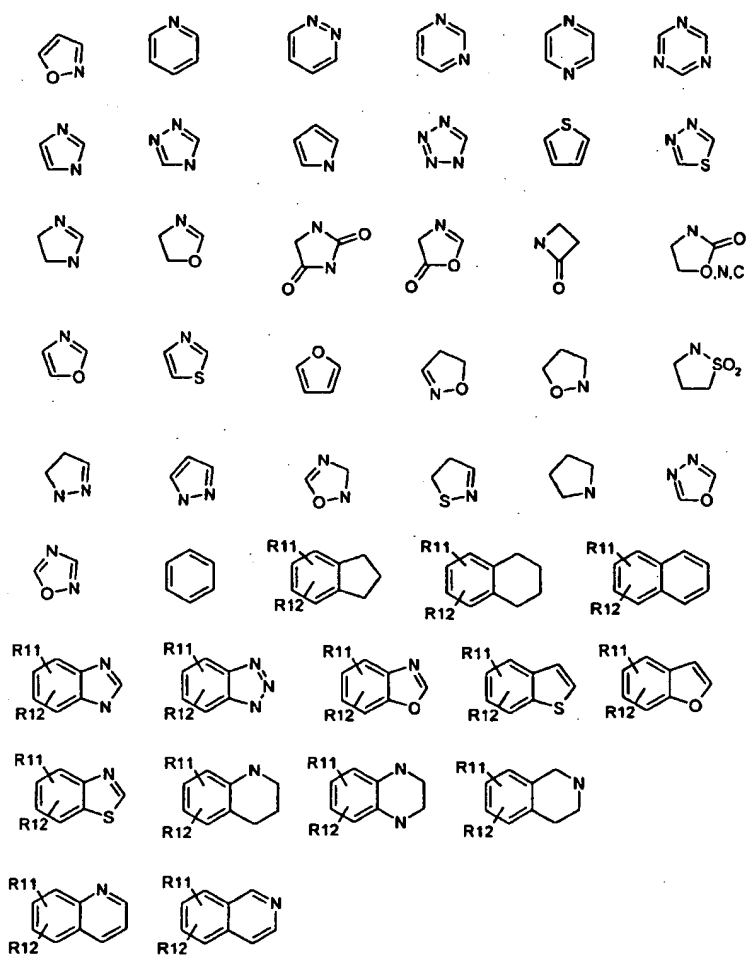
- n is 0, 1 or 2;
- q is 0 or 1;
- r is 0 or 1; when r is 0, Ar is replaced by hydrogen;
- 5     Ar is phenyl, pyridyl, pyrimidyl, thienyl, furyl, imidazolyl, pyrrolyl or thiazolyl each unsubstituted or substituted by from 1 to 3 substituents selected from acetyl, alkoxy, alkyl, amino, cyano, halo, hydroxy, nitro, sulfonamido, sulfonyl, -CF<sub>3</sub>, -OCF<sub>3</sub>, -CO<sub>2</sub>H, -CH<sub>2</sub>CN, -SO<sub>2</sub>CF<sub>3</sub>, -CH<sub>2</sub>CO<sub>2</sub>H and -  
10     (CH<sub>2</sub>)<sub>s</sub>NR<sup>7</sup>R<sup>8</sup> wherein s is 0, 1, 2 or 3 and R<sup>7</sup> and R<sup>8</sup> are each independently selected from H, straight or branched alkyl of up to 6 carbon atoms, or R<sup>7</sup> and R<sup>8</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-  
15     membered aliphatic ring which may contain 1 or 2 oxygen atoms;
- R<sup>1</sup> is hydrogen, straight or branched alkyl of up to 6 carbon atoms or cycloalkyl of between 5 and 7 carbon atoms which may contain 1 or 2 nitrogen or oxygen atoms;
- 15     • R<sup>6</sup> is hydrogen, methyl, or forms with R<sup>1</sup> an aliphatic ring of from 3 to 7 atoms which can contain an oxygen or nitrogen atom, or together with R<sup>1</sup> is a carbonyl group;
- Ar<sup>1</sup> is independently selected from Ar or is indolyl or pyridyl-*N*-oxide;
- R<sup>3</sup>, R<sup>4</sup>, and R<sup>5</sup> are each independently selected from hydrogen and lower  
20     alkyl;
- R<sup>2</sup> is independently selected from Ar or is hydrogen, hydroxy, alkoxy, -NMe<sub>2</sub>, -CONR<sup>9</sup>R<sup>10</sup> wherein R<sup>9</sup> and R<sup>10</sup> are each independently selected from  
25     hydrogen, straight or branched alkyl of up to 6 carbon atoms, or R<sup>9</sup> and R<sup>10</sup> together with the nitrogen atom to which they are linked can form a 5-to 7-  
25     membered aliphatic ring which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>2</sup> is



wherein p is 0, 1 or 2 and Ar<sup>2</sup> is phenyl or pyridyl;

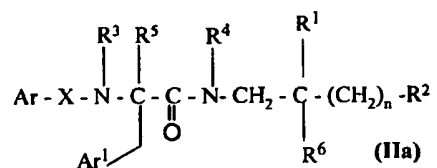
- X is a divalent radical derived from any of the following

5



where the ring nitrogen atoms may have lower alkyl groups attached thereto,  $R^{11}$  and  $R^{12}$  are independently selected from H, halogen, hydroxy, alkoxy, acetyl, nitro, cyano, amino,  $CF_3$  and  $-(CH_2)_tNR^{13}R^{14}$  where  $t$  can be 0 or 1,  $R^{13}$  and  $R^{14}$  are each independently selected from hydrogen, straight or branched alkyl of up to 6 carbon atoms or cycloalkyl of 5 to 7 carbon atoms, containing up to 2 oxygen or nitrogen atoms.

22 The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound of the formula (IIa), or a pharmaceutically acceptable salt thereof:



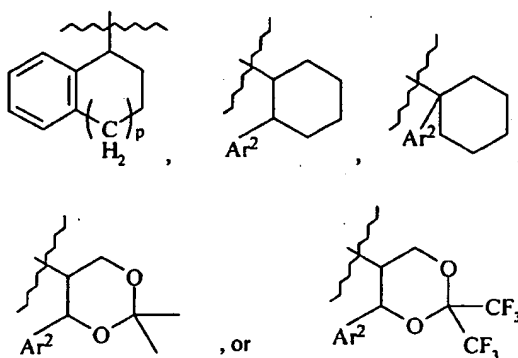
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wherein:

- $n$  is 0 or 1;
- $Ar$  is phenyl or pyridyl which may be unsubstituted or substituted with from 1 to 3 substituents selected from halogen, alkoxy, nitro and cyano;
- $Ar^1$  is independently selected from  $Ar$  or is pyridyl- $N$ -oxide or indolyl;
- $R^6$  forms with  $R^1$  an aliphatic ring of from 3 to 7 atoms which can contain an oxygen or nitrogen atom, or together with  $R^1$  is a carbonyl group;
- $R^2$  is independently selected from  $Ar$  or is hydrogen, hydroxy, alkoxy, dimethylamino, tetrazolyl or  $-CONR^9R^{10}$  wherein  $R^9$  and  $R^{10}$  are each independently selected from hydrogen or methyl or  $R^2$  is any of

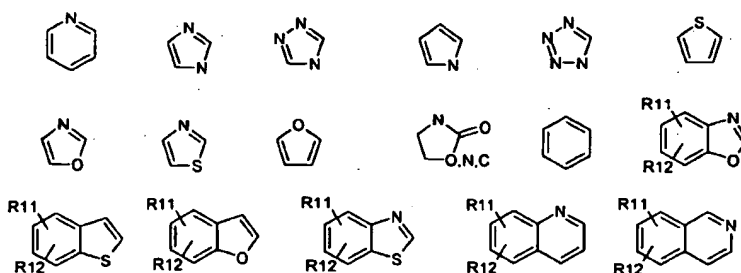
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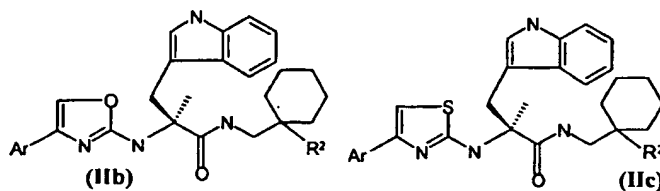
wherein  $p$  is 0, 1 or 2 and  $Ar^2$  is phenyl or pyridyl;

- $R^3$ ,  $R^4$  and  $R^5$  are each independently selected from hydrogen and methyl;
- and
- $X$  is selected from:



$R^{11}$  and  $R^{12}$  being independently selected from H, halogen, hydroxy, alkoxy, acetyl, nitro, cyano, amino,  $CF_3$  and  $(CH_2)_tNR^{13}R^{14}$  wherein  $t$  is 0 or 1 and  $R^{13}$  and  $R^{14}$  are independently selected from hydrogen and methyl.

23. The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound has the formula (IIb) or (IIc) or is a pharmaceutically acceptable salt thereof:



wherein Ar and R<sup>2</sup> independently represent phenyl or pyridyl which may be unsubstituted or substituted with from 1 to 3 substituents selected from halogen, alkoxy, nitro and cyano, and pharmaceutically acceptable salts thereof.

5

24. The combination of claim 1, wherein the bombesin receptor antagonist is (S)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide (also referred to as Compound 2) or a pharmaceutically acceptable salt.

10

25 The combination of claim 1, wherein the bombesin receptor antagonist is one of the following compounds or a pharmaceutically acceptable salt thereof:

(S)-3-(1*H*-indol-3-yl)-*N*-(1-methoxymethyl-cyclohexylmethyl)-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-propionamide;

15 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-*N*-(2-oxo-2-phenyl-ethyl)-propionamide;

(S)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-oxazol-2-ylamino]-3-phenyl-propionamide;

20 (S)-2-[4-(4-cyano-phenyl)-oxazol-2-ylamino]-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-propionamide;

(S)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-(4-phenyl-oxazol-2-ylamino)-propionamide;

(S)-2-(4-ethyl-oxazol-2-ylamino)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-propionamide;

25 (S)-3-(1*H*-indol-3-yl)-*N*-[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-2-methyl-2-[4-(4-nitro-phenyl)-thiazol-2-ylamino]-propionamide;

(S)-2-(benzooxazol-2-ylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

30 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(pyridin-4-ylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;



(S)-3-(1*H*-indol-3-yl)-2-(isoquinol-4-ylamino)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(pyrimidin-5-ylamino)-propionamide;

5 (S)-2-(biphenyl-2-ylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-*m*-tolylamino-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(6-phenyl-pyridin-2-ylamino)-*N*-(1-pyridin-10 2-yl-cyclohexylmethyl)-propionamide;

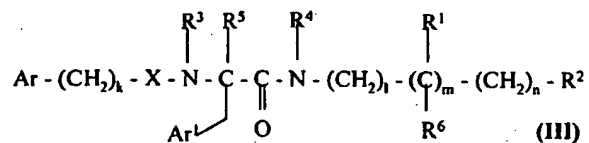
(*R*)-3-phenyl-2-phenylamino-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-phenylethylamino-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

15 (S)-2-[(benzofuran-2-ylmethyl)-amino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide, and

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(4-nitro-benzylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide.

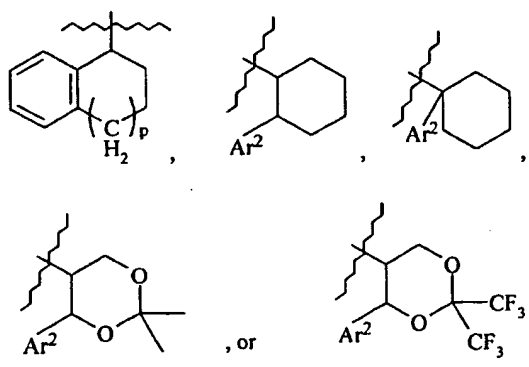
20 26. The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound of formula (III) or a pharmaceutically acceptable salt thereof:



wherein:

- 25
- *k* is 0, 1 or 2;
  - *l* is 0, 1, 2 or 3;
  - *m* is 0 or 1;
  - *n* is 0, 1 or 2;
  - *X* is -CO-, -OCO-, -SO- and -SO<sub>2</sub>-;

- Ar is benzimidazolyl, benzofuryl, benzothiadiazolyl, benzothiazolyl, benzothieryl, benzopyrazinyl, benzotriazolyl, benzoxadiazolyl, furyl, imidazolyl, indanyl, indolyl, isoquinolyl, isoxazolyl, naphthyl, oxazolyl, phenyl, pyrazinyl, pyrazolyl, pyridyl, pyridazinyl, pyrimidyl, pyrrolyl, quinolinyl, tetralinyl, tetrazolyl, thiazolyl, thienyl or triazolyl each unsubstituted or substituted with from 1 to 3 substituents selected from amino, acetyl, alkyl (straight chain or branched with from 1 to 6 carbon atoms), alkoxy, cyano, halogen, hydroxy, nitro, phenyl, pyridyl, pyrrolyl, isoxazolyl, phenoxy, tolyloxy, -CF<sub>3</sub>, -OCF<sub>3</sub>, -SO<sub>2</sub>CF<sub>3</sub>, -NHCONH<sub>2</sub>, -CO<sub>2</sub>H, -CH<sub>2</sub>CO<sub>2</sub>H, -CH<sub>2</sub>CN, SO<sub>2</sub>Me, SO<sub>2</sub>NH<sub>2</sub>, SO<sub>2</sub>Ph, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, -CONR<sup>9</sup>R<sup>10</sup>, and CO<sub>2</sub>R<sup>11</sup>, wherein q is 0, 1 or 2 and R<sup>7</sup>, R<sup>8</sup>, R<sup>9</sup>, R<sup>10</sup>, R<sup>11</sup> are each independently selected from hydrogen or straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 to 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms or R<sup>7</sup> and R<sup>8</sup> or R<sup>9</sup> and R<sup>10</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-membered aliphatic ring which may contain 1 or 2 oxygen or nitrogen atoms;
- Ar<sup>1</sup> is independently selected from Ar and can also be pyridyl-*N*-oxide;
- R<sup>1</sup> is hydrogen or straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 and 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms;
- R<sup>2</sup> is independently selected from Ar or is hydrogen, hydroxy, alkoxy, -NMe<sub>2</sub>, -CONR<sup>12</sup>R<sup>13</sup>,



wherein p is 0, 1 or 2, Ar<sup>2</sup> is phenyl or pyridyl; and, R<sup>12</sup> and R<sup>13</sup> are each independently selected from hydrogen, straight or branched alkyl of up to 6 carbon atoms or cyclic alkyl of between 5 and 7 carbon atoms;

- R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are each independently selected from hydrogen and lower alkyl; and
- R<sup>6</sup> is hydrogen, methyl or forms with R<sup>1</sup> a ring of from 3 to 7 carbon atoms which can contain an oxygen or nitrogen atom, or R<sup>1</sup> and R<sup>6</sup> can together be carbonyl.

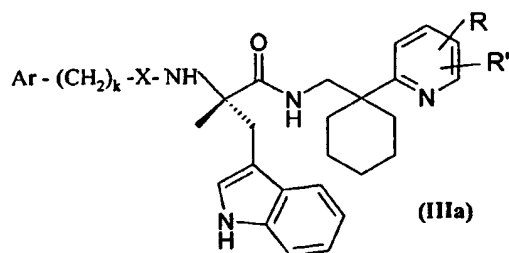
27. The combination of claim 26, wherein the bombesin receptor antagonist is a compound formula (III) in which:

- k is 0 or 1;
- l is 1;
- m is 0 or 1;
- n is 0 or 1;
- X is -C(O)-, -OC(O)-, or -SO<sub>2</sub>-;
- Ar is benzofuryl, furyl, indolyl, isoquinolyl, naphthyl, phenyl, pyridyl, quinolyl or thienyl each unsubstituted or substituted with 1 or 2 substituents selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy, -CF<sub>3</sub>, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, wherein R<sup>7</sup> and R<sup>8</sup> can form a ring of between 5 to 7 atoms which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>7</sup> and R<sup>8</sup> can be independently selected from hydrogen, straight or branched alkyl of up to 4 carbon atoms or cyclic alkyl of 5 carbon atoms;
- Ar<sup>1</sup> is independently selected from Ar, preferably indolyl, and can also be pyridyl-N-oxide;
- R<sup>1</sup> and R<sup>6</sup> can form a cyclic alkyl of from 5 to 7 carbon atoms or R<sup>1</sup> and R<sup>6</sup> together are carbonyl;
- R<sup>2</sup> is independently selected from unsubstituted or substituted pyridyl or is hydrogen, hydroxy, alkoxy, -NMe<sub>2</sub>, -CONR<sup>12</sup>R<sup>13</sup> wherein R<sup>12</sup> and R<sup>13</sup> are each independently selected from H and CH<sub>3</sub>;
- R<sup>3</sup>, R<sup>4</sup> and R<sup>5</sup> are each independently selected from hydrogen and methyl.

28. The combination of claim 27, wherein the bombesin receptor antagonist is a compound of Formula (III) in which,

- l is 1;
- 5     • m is 1;
- n is 0;
- R<sup>2</sup> is 2-pyridyl;
- R<sup>6</sup> forms a cyclohexyl with R<sup>1</sup>.

- 10   29. The combination of any of claims 1-14, wherein the bombesin receptor antagonist is a compound of formula (IIIa) or a salt thereof:



- wherein Ar, k and X have the meanings given above in first, and the pyridine ring is optionally substituted by with 1 or 2 substituents, R and R', independently selected from alkoxy, cyano, halogen, nitro, phenyl, phenoxy, -CF<sub>3</sub>, -(CH<sub>2</sub>)<sub>q</sub>NR<sup>7</sup>R<sup>8</sup>, wherein R<sup>7</sup> and R<sup>8</sup> together with the nitrogen atom to which they are linked can form a 5- to 7-membered aliphatic ring which may contain 1 or 2 oxygen or nitrogen atoms, or R<sup>7</sup> and R<sup>8</sup> can be independently selected from hydrogen or cyclic alkyl of between 5 to 7 carbon atoms, and their pharmaceutically acceptable salts thereof.

30. The combination of claim 1, wherein the bombesin receptor antagonist is one of the following compounds or a salt thereof :

25     *N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-4-nitro-benzamide;

*C*-dimethylamino-*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl)-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide;

1*H*-indole-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

benzo[b]thiophene-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

5 N-[(S)-2-(1*H*-Indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-2-pyrrol-1-yl-benzamide

1*H*-indole-5-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide; and

10 1*H*-indole-2-carboxylic acid ((S)-2-(1*H*-indol-3-yl)-1-[[1-(5-methoxy-pyridin-2-yl)-cyclohexylmethyl]-carbamoyl]-1-methyl-ethyl)-amide.

31. The combination of claim 1, wherein the bombesin receptor antagonist is one of the following compounds or a salt thereof

15 N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-benzamide;

N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-4-methyl-benzamide;

4-chloro-N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-benzamide;

20 N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-4-methoxy-benzamide;

N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-4-methanesulfonyl-benzamide;

25 3-cyano-N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-benzamide;

3-chloro-N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-benzamide;

N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-3-methoxy-benzamide;

30 N-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl]-3-methanesulfonyl-benzamide;

- dimethylamino-*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide;
- N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-3-methyl-benzamide;
- 5        2-chloro-*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide;
- N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-nitro-benzamide;
- N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-methoxy-benzamide;
- 10        *N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-methyl-benzamide;
- 2-fluoro-*N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-benzamide;
- 15        (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-*p*-tolyl-ethanoylamino)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-*o*-tolyl-ethanoylamino)-propionamide;
- (S)-2-[2-(4-hydroxy-phenyl)-ethanoylamino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 20        (S)-2-[2-(3-hydroxy-phenyl)-ethanoylamino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-*m*-tolyl-ethanoylamino)-propionamide;
- 25        (S)-2-[2-(2-fluoro-phenyl)-ethanoylamino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-thiophen-3-yl-ethanoylamino)-propionamide;
- pyridine-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide
- 30        *N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-

carbamoyl]-ethyl}-isonicotinamide;

furan-3-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

5 furan-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

5-methyl-isoxazole-3-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

1-methyl-1*H*-pyrrole-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

10 thiophene-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

thiophene-3-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

15 1*H*-indole-6-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

1*H*-indole-5-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

1*H*-indole-4-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

20 1*H*-indole-7-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

1-methyl-1*H*-indole-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

25 benzothiazole-6-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

1*H*-benzotriazole-5-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

3-methyl-thiophene-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

30 5-methyl-thiophene-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;

- 6-methyl-pyridine-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;
- isoquinoline-3-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;
- 5 quinoxaline-2-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;
- quinoline-8-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;
- 5-phenyl-oxazole-4-carboxylic acid {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-amide;
- 10 (S)-3-(1*H*-indol-3-yl)-2-[2-(4-methoxy-phenyl)-ethanoylamino]-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-[2-(4-dimethylamino-phenyl)-ethanoylamino]-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 15 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-[2-(2-nitro-phenyl)-ethanoylamino]-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-[2-(2-methoxy-phenyl)-ethanoylamino]-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide; and
- N*-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-2-pyrrol-1-yl-benzamide.
- 20

32. The combination of claim 1, wherein the bombesin receptor antagonist is one of the following compounds or a salt thereof
- {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid naphthalen-1-ylmethyl ester;
- 25 {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3,4-dichloro-benzyl ester;
- {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-nitro-benzyl ester;
- 30 {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethyl}-carbamic acid 3-trifluoromethyl-benzyl ester;



{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid quinolin-6-ylmethyl ester;

{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-nitro-benzyl ester; and

5        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 3-cyano-benzyl ester.

33.    The combination of claim 1, wherein the bombesin receptor antagonist is one  
of the following compounds or a salt thereof:

10        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 3,4-dimethoxy-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid naphthalen-2-ylmethyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
15 carbamoyl]-ethyl}-carbamic acid indan-2-yl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-methoxy-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-chloro-benzyl ester;

20        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 2-fluoro-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 2-chloro-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
25 carbamoyl]-ethyl}-carbamic acid 2-methyl-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-tert-butyl-benzyl ester;

          {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 2-methoxy-benzyl ester;

30        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-trifluoromethyl-benzyl ester;

{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 3-ethoxy-benzyl ester;

{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 2,4-dichloro-benzyl ester;

5        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 3-methyl-benzyl ester;

{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 3-phenoxy-benzyl ester; and

10        {(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-  
carbamoyl]-ethyl}-carbamic acid 4-methyl-benzyl ester.

34        The combination of claim 1, wherein the bombesin receptor antagonist is one  
of the following compounds or a salt thereof:

15        (S)-3-(1*H*-indol-3-yl)-2-methyl-2-phenylmethanesulfonylamino-*N*-(1-pyridin-  
2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(2-chloro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-  
pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(naphthalene-1-sulfonylamino)-*N*-(1-  
pyridin-2-yl-cyclohexylmethyl)-propionamide;

20        (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-  
(quinoline-8-sulfonylamino)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-  
trifluoromethyl-benzenesulfonylamino)-propionamide;

25        (S)-2-(biphenyl-2-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-  
yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(5-methyl-2-phenoxy-benzenesulfonyl-  
amino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide; and

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2-*p*-  
tolylloxy-benzenesulfonylamino)-propionamide.

35. The combination of claim 1, wherein the bombesin receptor antagonist is one of the following compounds or a salt thereof:

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(toluene-4-sulfonylamino)-propionamide;

5 (S)-3-(1*H*-indol-3-yl)-2-methanesulfonylamino-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(2-fluoro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

10 (S)-2-(4-chloro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2,2,2-trifluoro-ethanesulfonylamino)-propionamide;

(S)-2-(5-dimethylamino-naphthalene-1-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

15 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(naphthalene-2-sulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(thiophene-2-sulfonylamino)-propionamide;

20 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(3-nitro-benzenesulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(4-fluoro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(4-nitro-benzenesulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

25 (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(3-trifluoromethyl-benzenesulfonylamino)-propionamide;

(S)-2-(3,4-dichloro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

30 (S)-2-(3-fluoro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(4-trifluoromethyl-benzenesulfonylamino)-propionamide;
- (S)-2-(5-chloro-thiophene-2-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 5 (S)-2-(3-chloro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(toluene-3-sulfonylamino)-propionamide;
- (S)-2-(3,4-dimethoxy-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 10 (S)-2-(4-cyano-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(2-cyano-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 15 (S)-2-(5-chloro-1,3-dimethyl-1*H*-pyrazole-4-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(3,5-dimethyl-isoxazole-4-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(benzo[1,2,5]thiadiazole-4-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 20 (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(1-methyl-1*H*-imidazole-4-sulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(benzo[1,2,5]oxadiazole-4-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 25 3-{(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethylsulfamoyl}-thiophene-2-carboxylic acid methyl ester;
- (S)-3-(1*H*-indol-3-yl)-2-(5-isoxazol-3-yl-thiophene-2-sulfonylamino)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(2-nitro-phenylmethanesulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 30

- (S)-2-(3-cyano-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(1,2-dimethyl-1*H*-imidazole-4-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 5 (S)-3-(1*H*-indol-3-yl)-2-(3-methoxy-benzenesulfonylamino)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-2-(8-nitro-naphthalene-1-sulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(2-chloro-5-nitro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 10 (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(2,4,6-trichloro-benzenesulfonylamino)-propionamide;
- (S)-2-(4-chloro-2-nitro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 15 (S)-2-(5-benzenesulfonyl-thiophene-2-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(4-trifluoromethoxy-benzenesulfonylamino)-propionamide;
- 20 2-[(S)-2-(1*H*-indol-3-yl)-1-methyl-1-[(1-pyridin-2-yl-cyclohexylmethyl)-carbamoyl]-ethylsulfamoyl]-benzoic acid methyl ester;
- (S)-2-(3-chloro-4-fluoro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-2-(2,5-dichloro-thiophene-3-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- 25 (S)-2-(3-chloro-4-methyl-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-(2-methoxy-4-methyl-benzenesulfonylamino)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;
- (S)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-2-(5-pyridin-2-yl-thiophene-2-sulfonylamino)-propionamide;
- 30

(S)-2-(5-bromo-6-chloro-pyridine-3-sulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(2,4-dinitro-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

5 (S)-3-(1*H*-indol-3-yl)-2-(4-methanesulfonyl-benzenesulfonylamino)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(4-*tert*-butyl-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

10 (S)-2-(2,4-dichloro-5-methyl-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-2-(2-chloro-5-trifluoromethyl-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide;

(S)-3-(1*H*-indol-3-yl)-2-methyl-2-(2-nitro-4-trifluoromethyl-benzenesulfonylamino)-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide; and

15 (S)-2-(4-butyl-benzenesulfonylamino)-3-(1*H*-indol-3-yl)-2-methyl-*N*-(1-pyridin-2-yl-cyclohexylmethyl)-propionamide.

20 36. The combination of any preceding claim, which is in the form of a pharmaceutical composition further comprising a pharmaceutically acceptable excipient.

37. The combination of any preceding claim, adapted for oral administration.

25 38. Use of a combination as claimed in any preceding claim in the preparation of a medicament for the treatment or prophylaxis of male sexual dysfunction (more particularly male erectile dysfunction) and/or female sexual dysfunction (more particularly hypoactive sexual desire disorders, sexual arousal disorders, anorgasmic disorders or sexual pain disorders).

30 39. A pharmaceutical combination (for simultaneous, separate or sequential administration) of a bombesin receptor antagonist and a PDE 5 inhibitor.

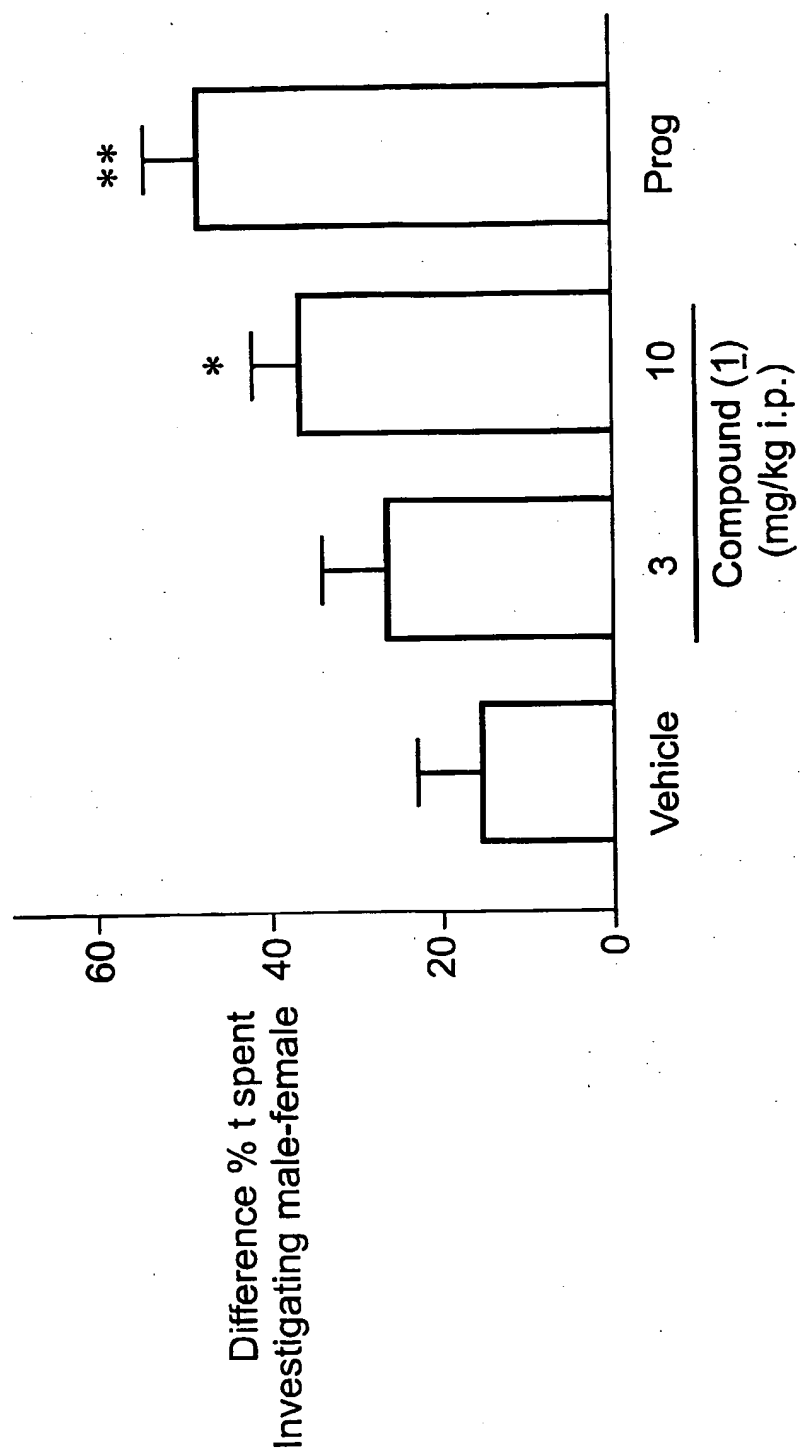
40. A pharmaceutical combination (for simultaneous, separate or sequential administration) of a bombesin receptor antagonist and a NEP inhibitor.
- 5 41. A pharmaceutical combination (for simultaneous, separate or sequential administration) of a bombesin receptor antagonist and one or more estrogen receptor modulators (SERM) and/or estrogen agonists and/or estrogen antagonists.
42. A pharmaceutical combination (for simultaneous, separate or sequential  
10 administration) of a bombesin receptor antagonist and lasofoxifene.
43. A method of treating drug induced sexual dysfunction (particularly but not exclusively dysfunction induced by antidepressants) in a male comprising administering to a male suffering therefrom an effective amount of a bombesin BB1  
15 antagonist or a mixed BB1/BB2 antagonist.
44. A method of treating drug induced sexual dysfunction (particularly but not exclusively dysfunction induced by antidepressants) in a female comprising administering to a female suffering therefrom an effective amount of a bombesin BB1  
20 antagonist or a mixed BB1/BB2 antagonist.
45. A method for treating erectile dysfunction in a male comprising administering to a male suffering therefrom an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist .
- 25 46. A method for treating a female patient suffering from hypoactive sexual desire disorder comprising administering to the female patient an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist.

47. A method for treating a female patient suffering from sexual arousal disorder and/or orgasmic disorder comprising administering to the female patient an effective amount of a bombesin BB1 antagonist or a mixed BB1/BB2 antagonist.



1/25

FIG. 1



2/25

FIG. 2

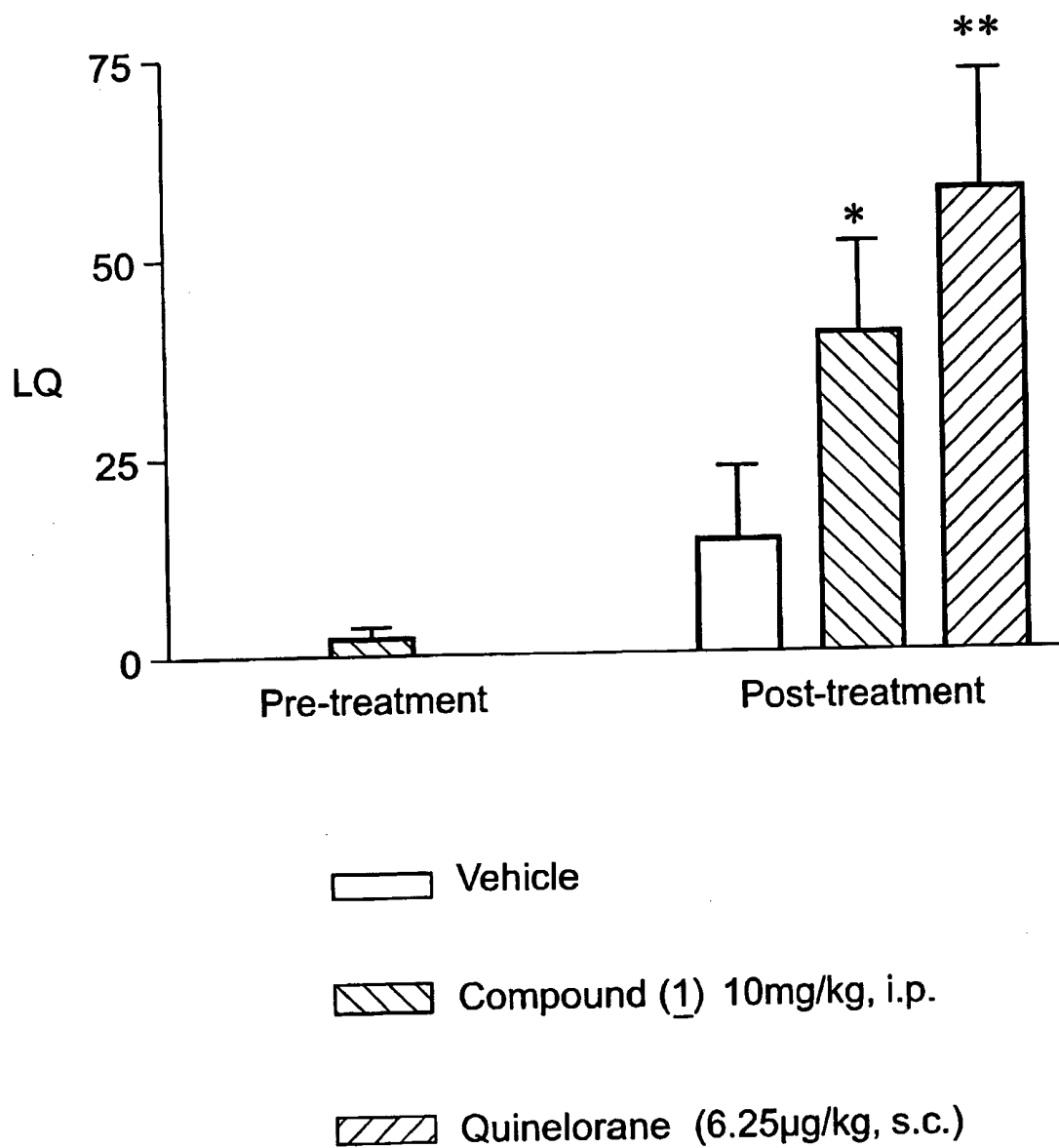
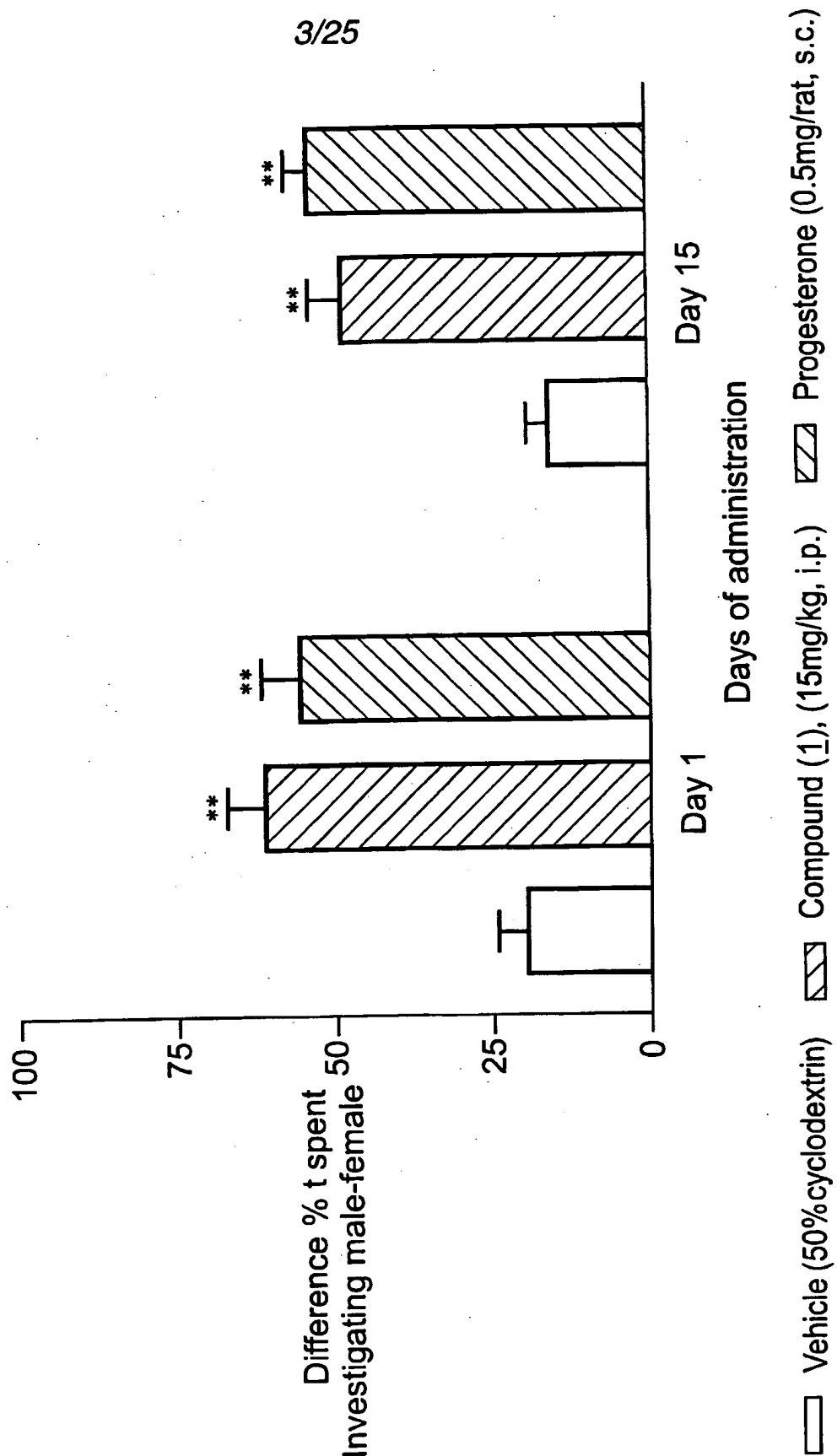


FIG. 3



4/25

FIG. 4

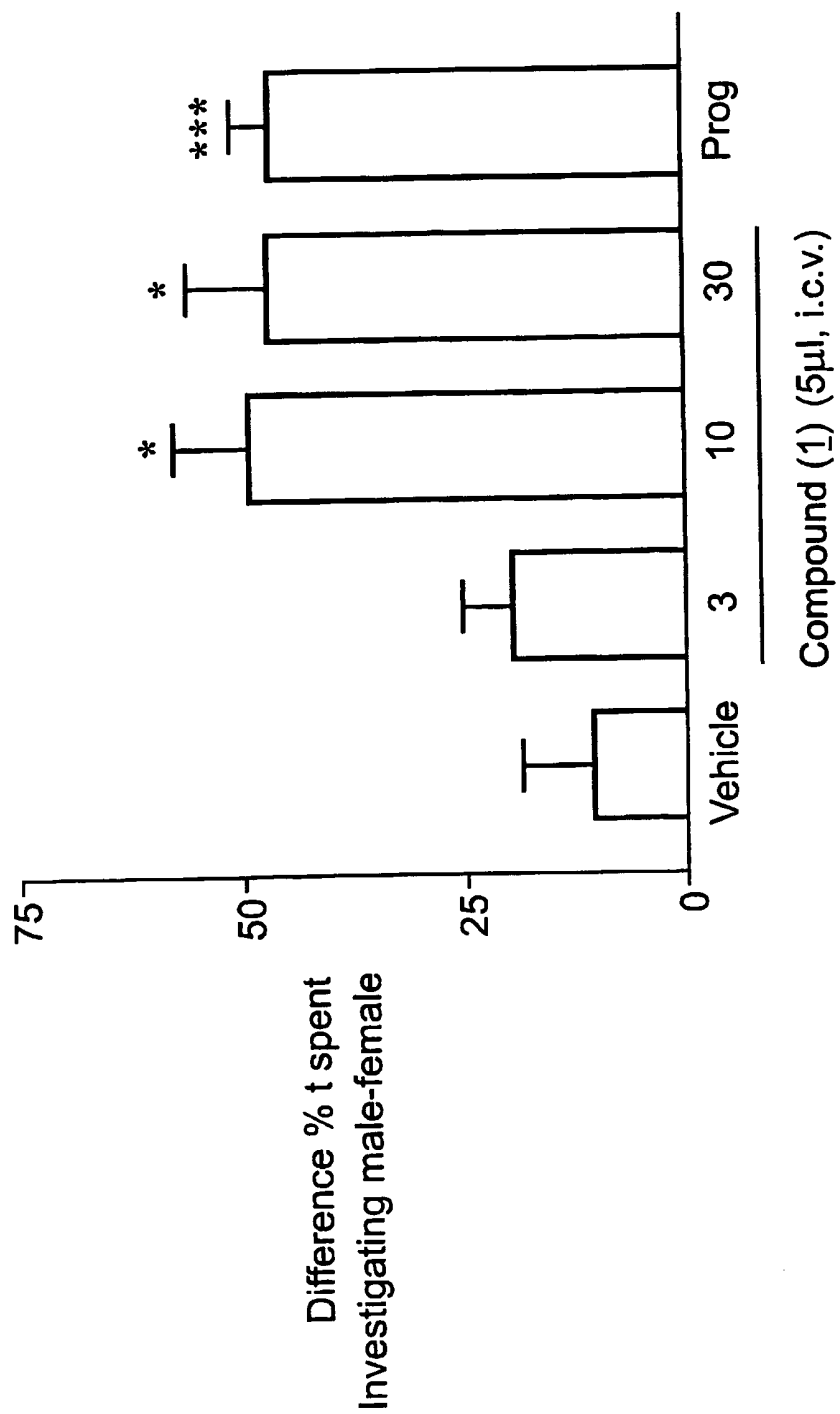
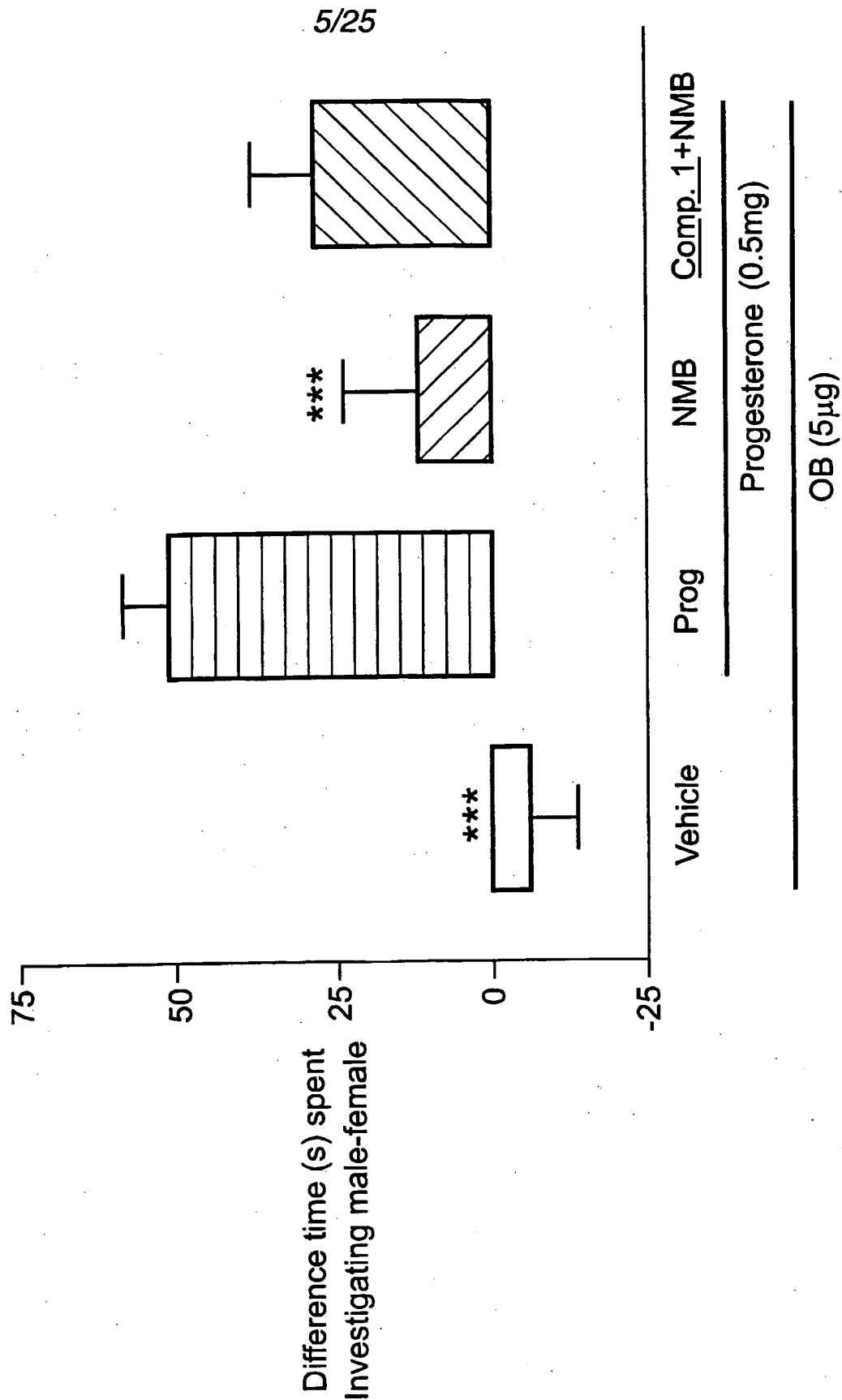
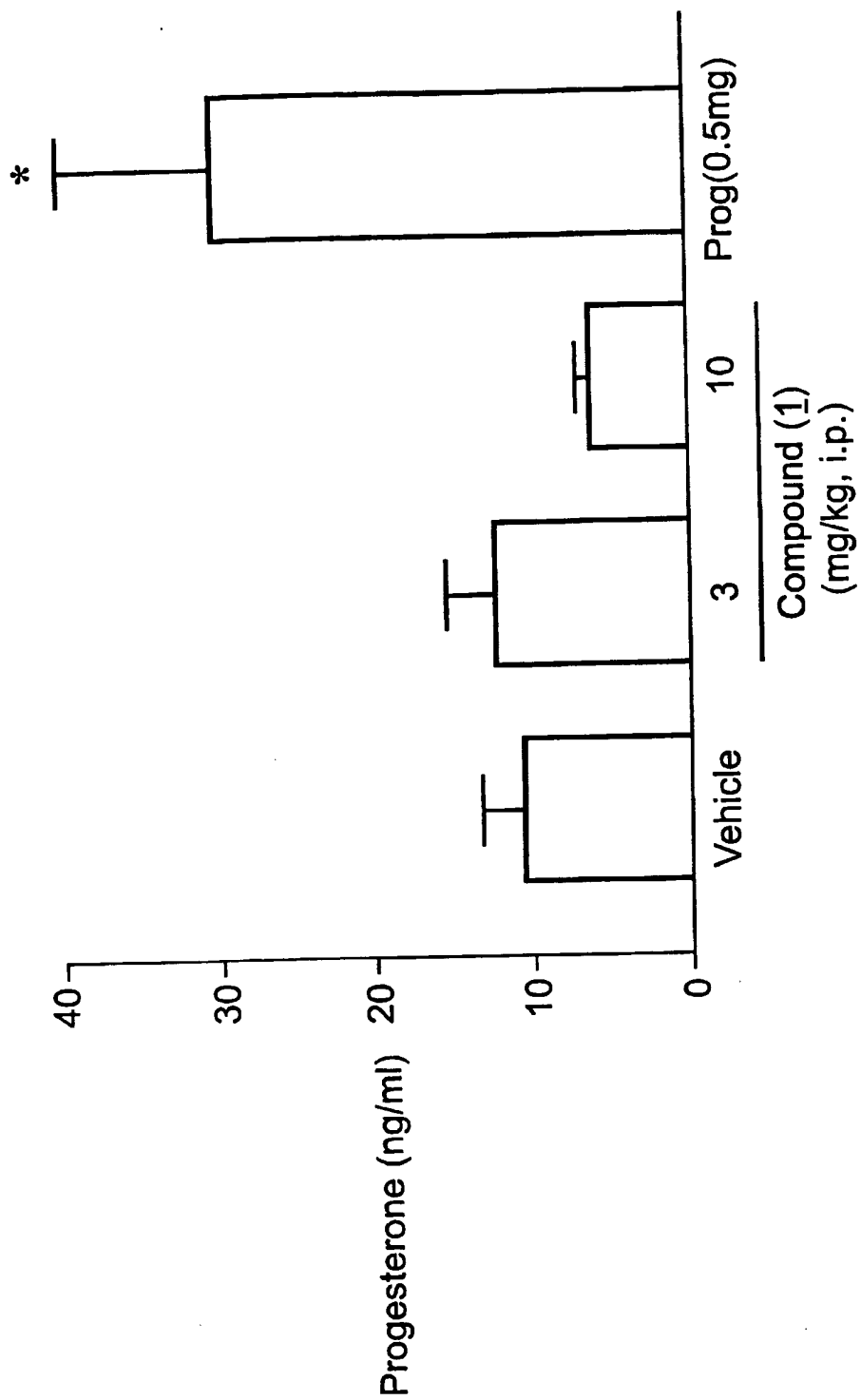


FIG. 5



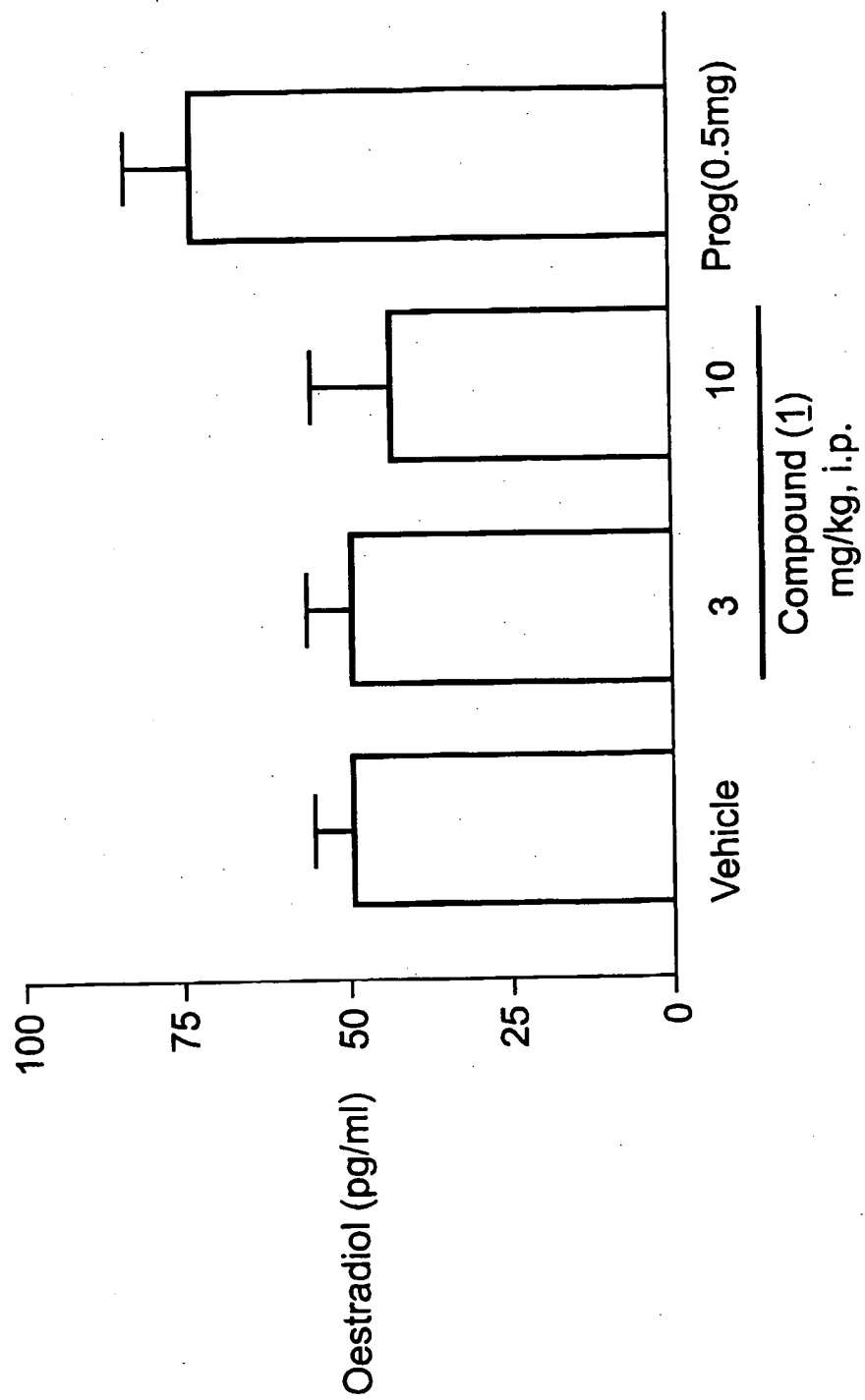
6/25

FIG. 6



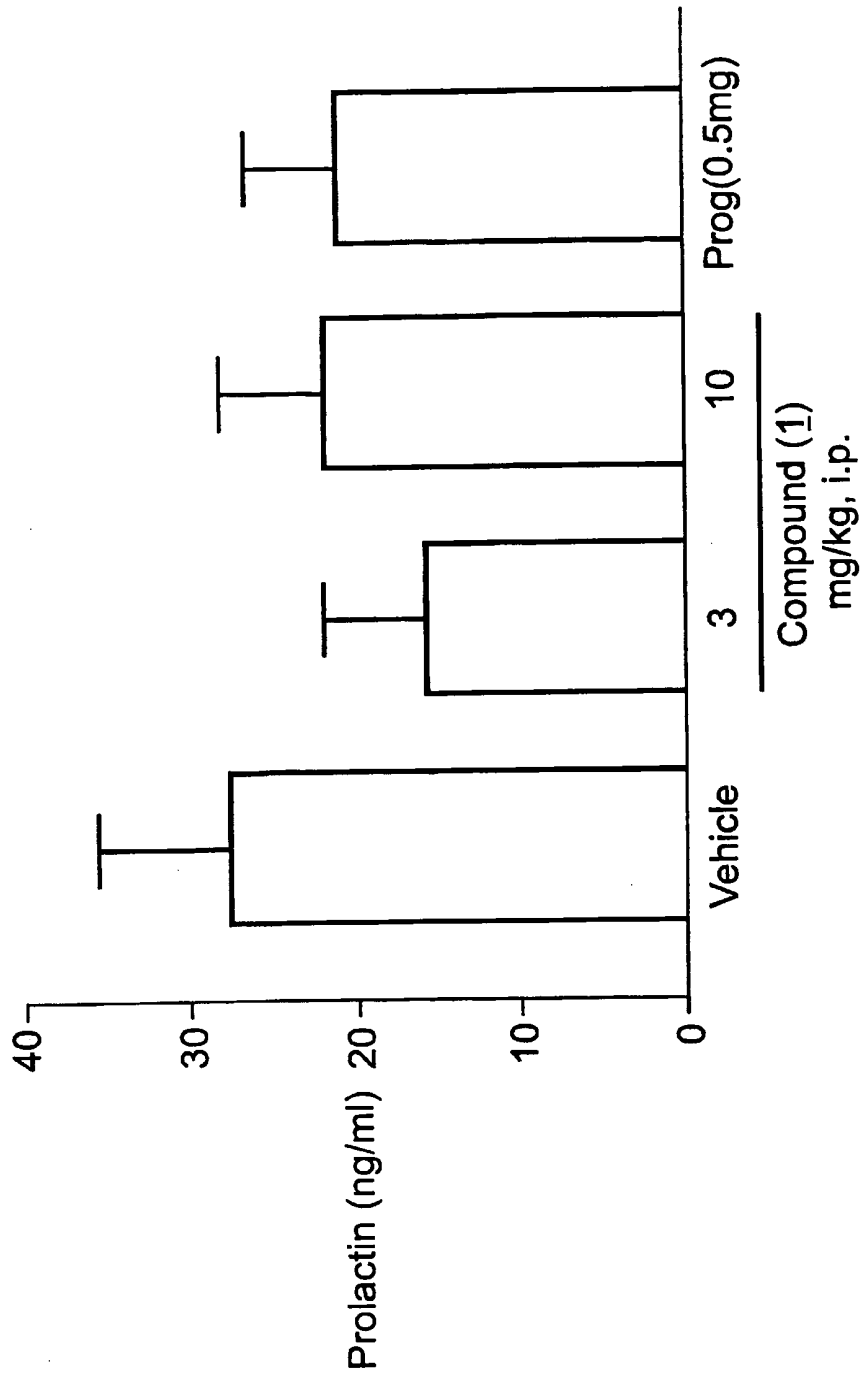
7/25

FIG. 7



8/25

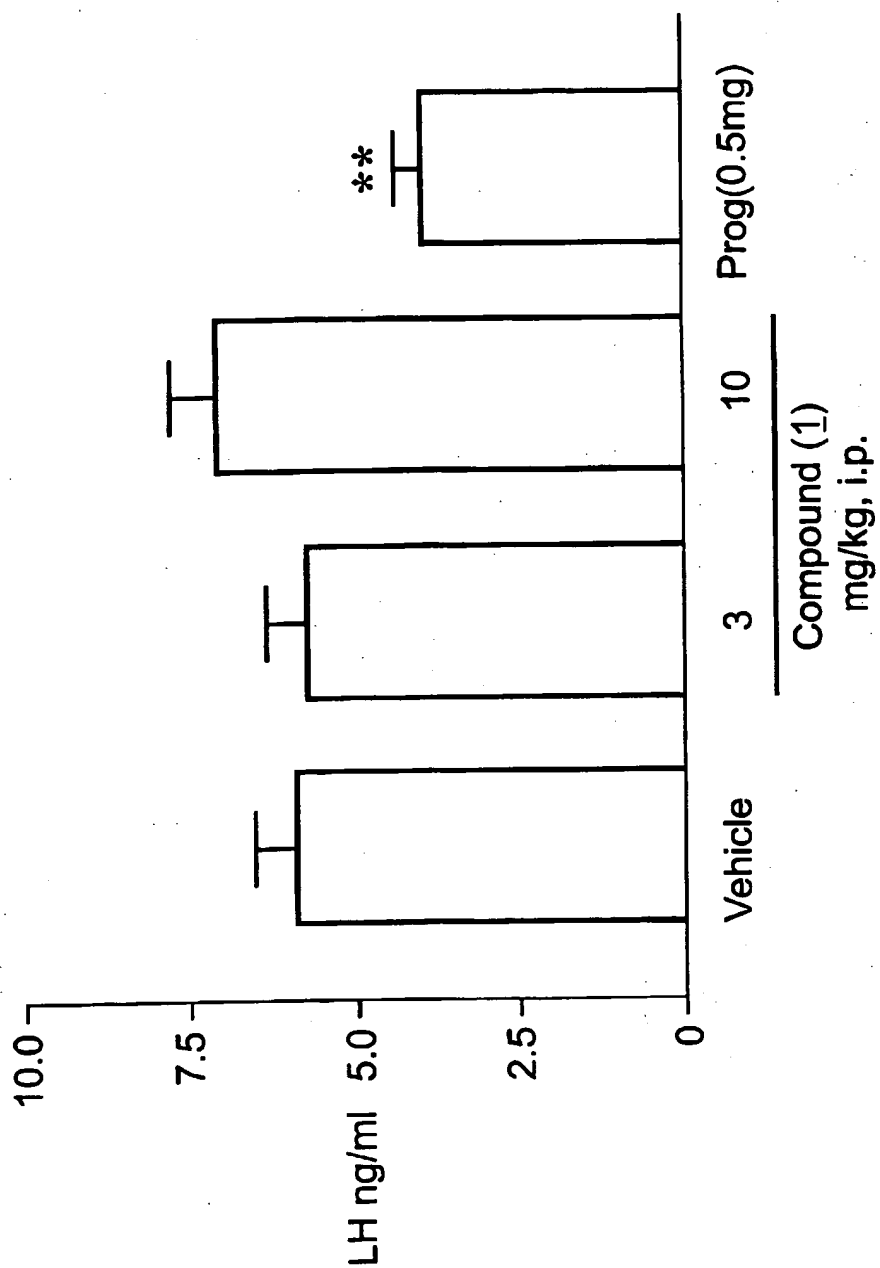
FIG. 8





9/25

FIG. 9



10/25

FIG. 10

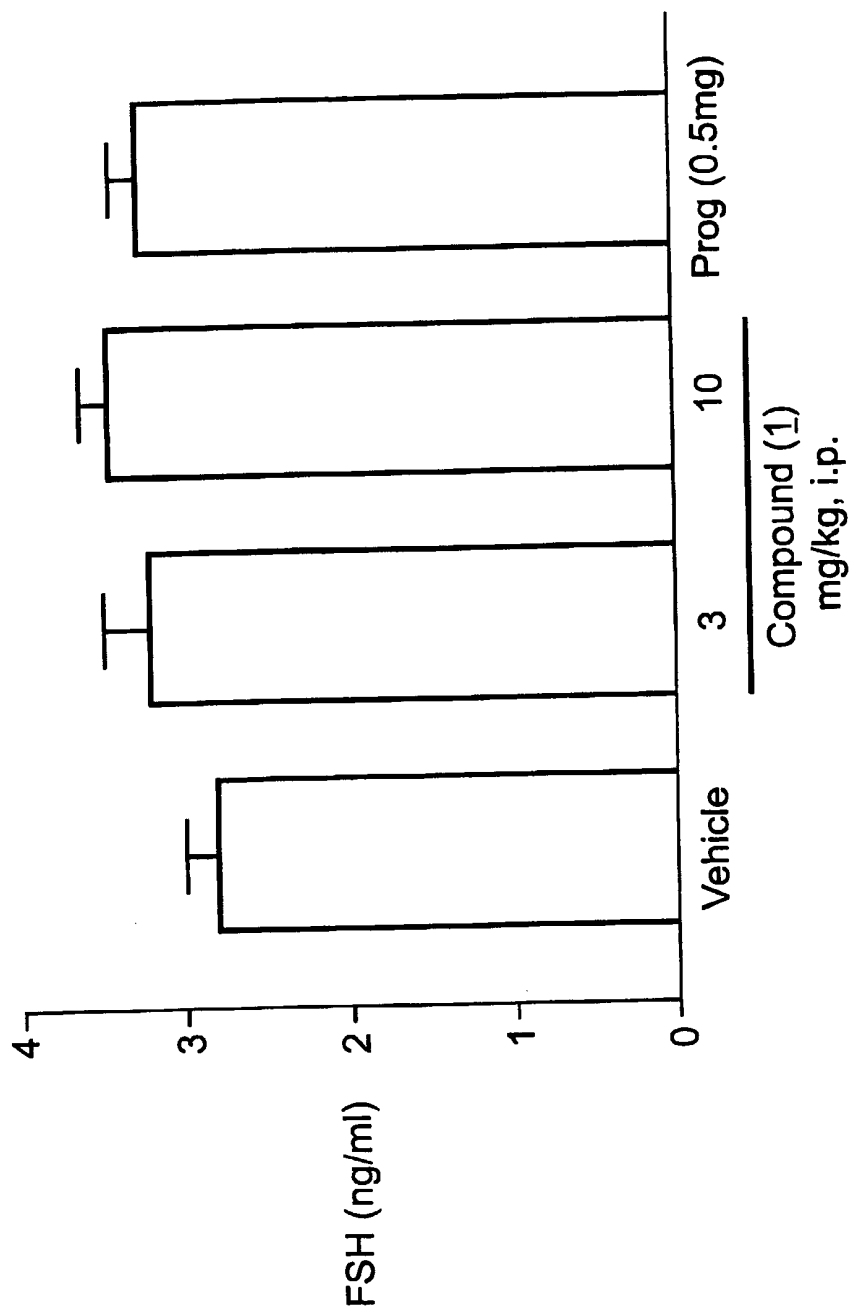


FIG. 11

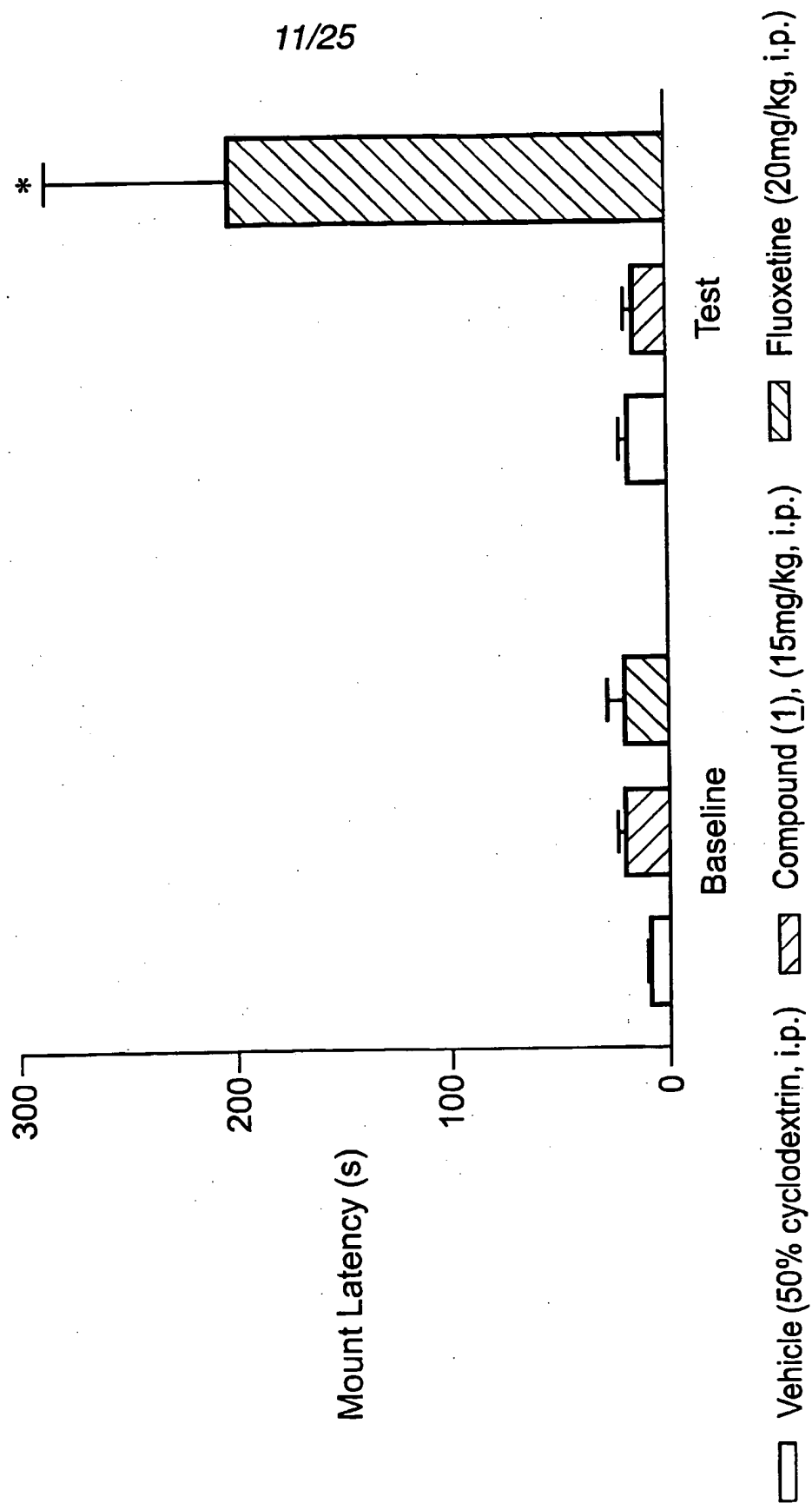


FIG. 12

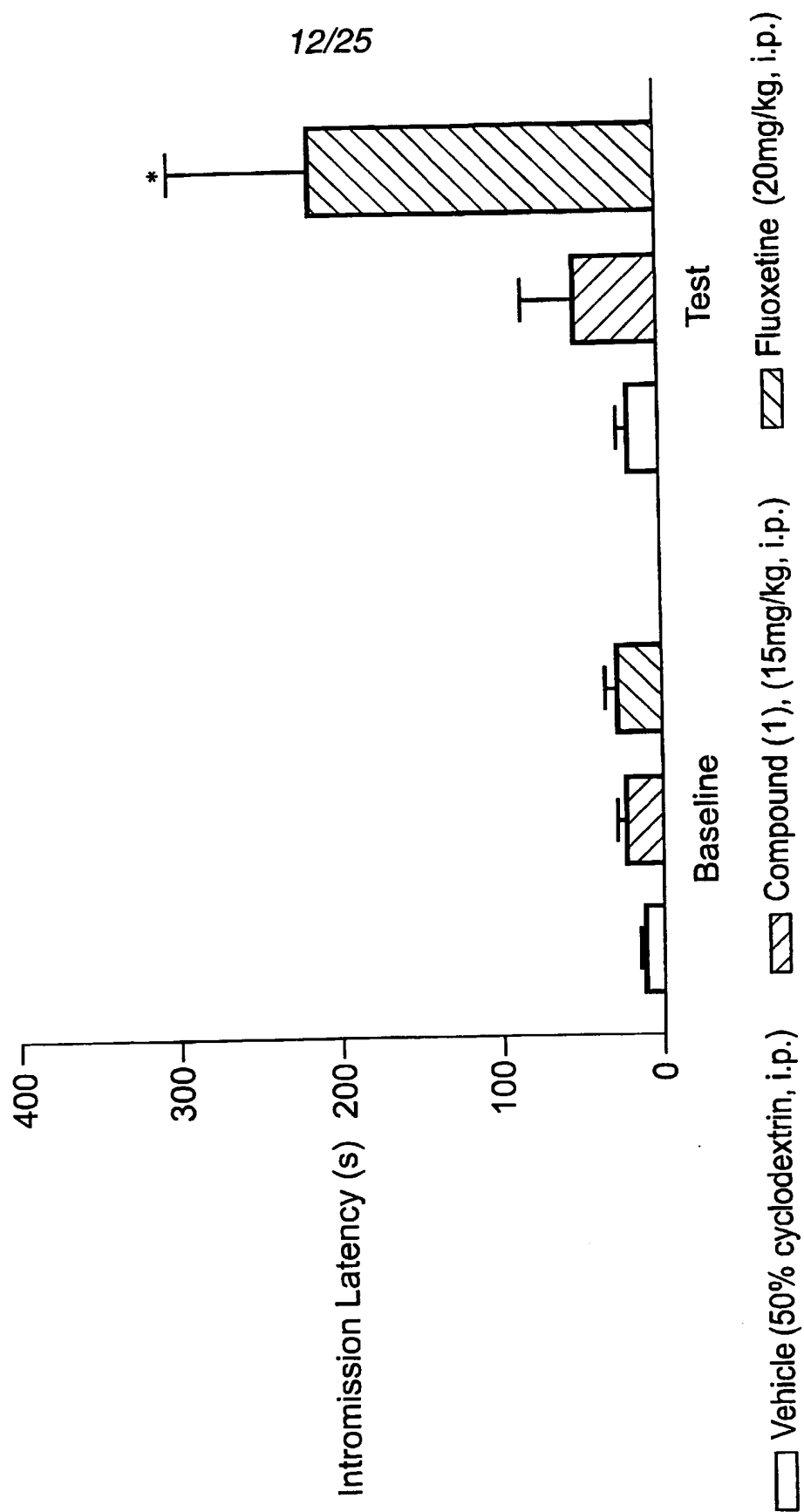


FIG. 13

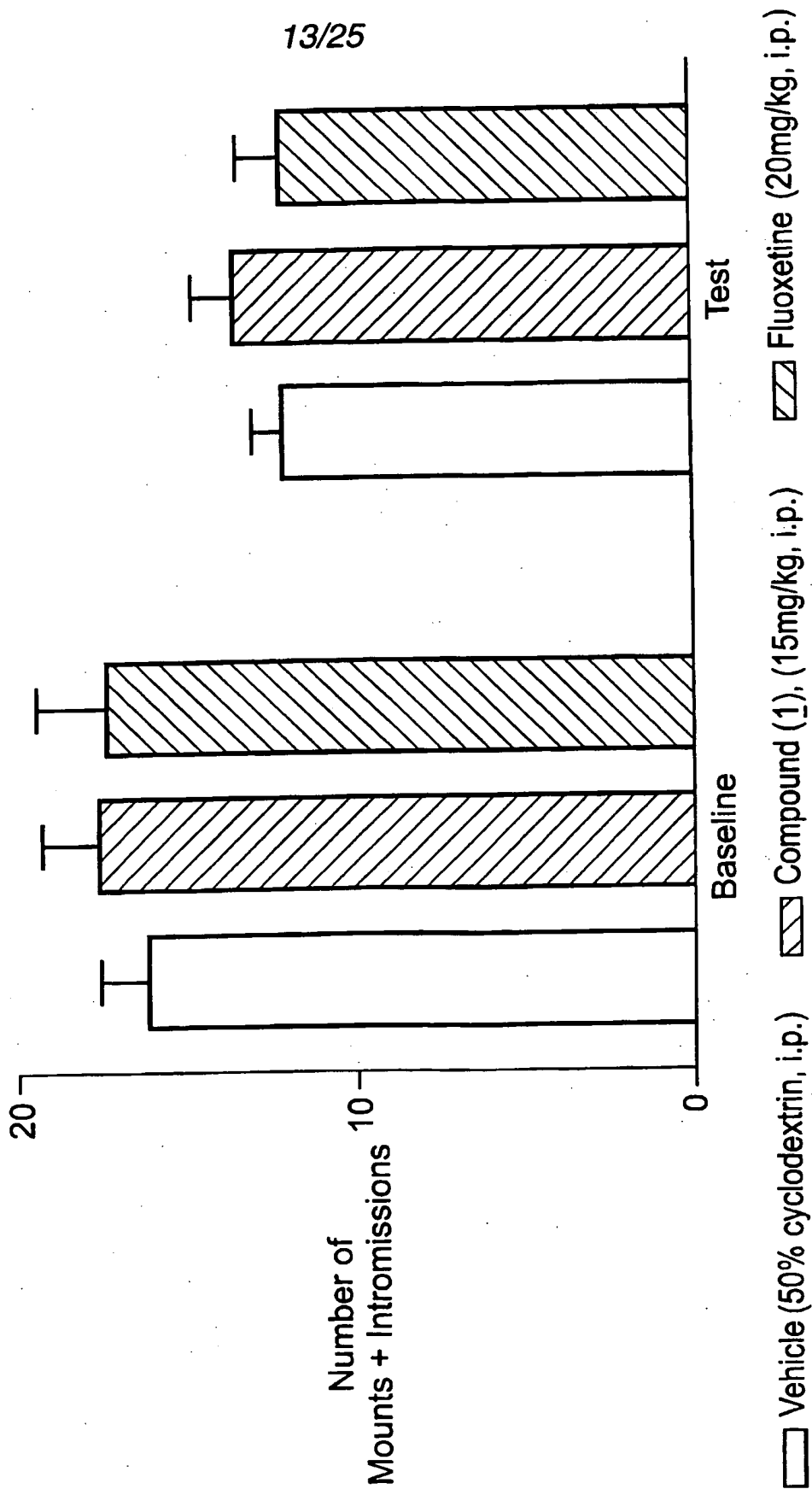


FIG. 14

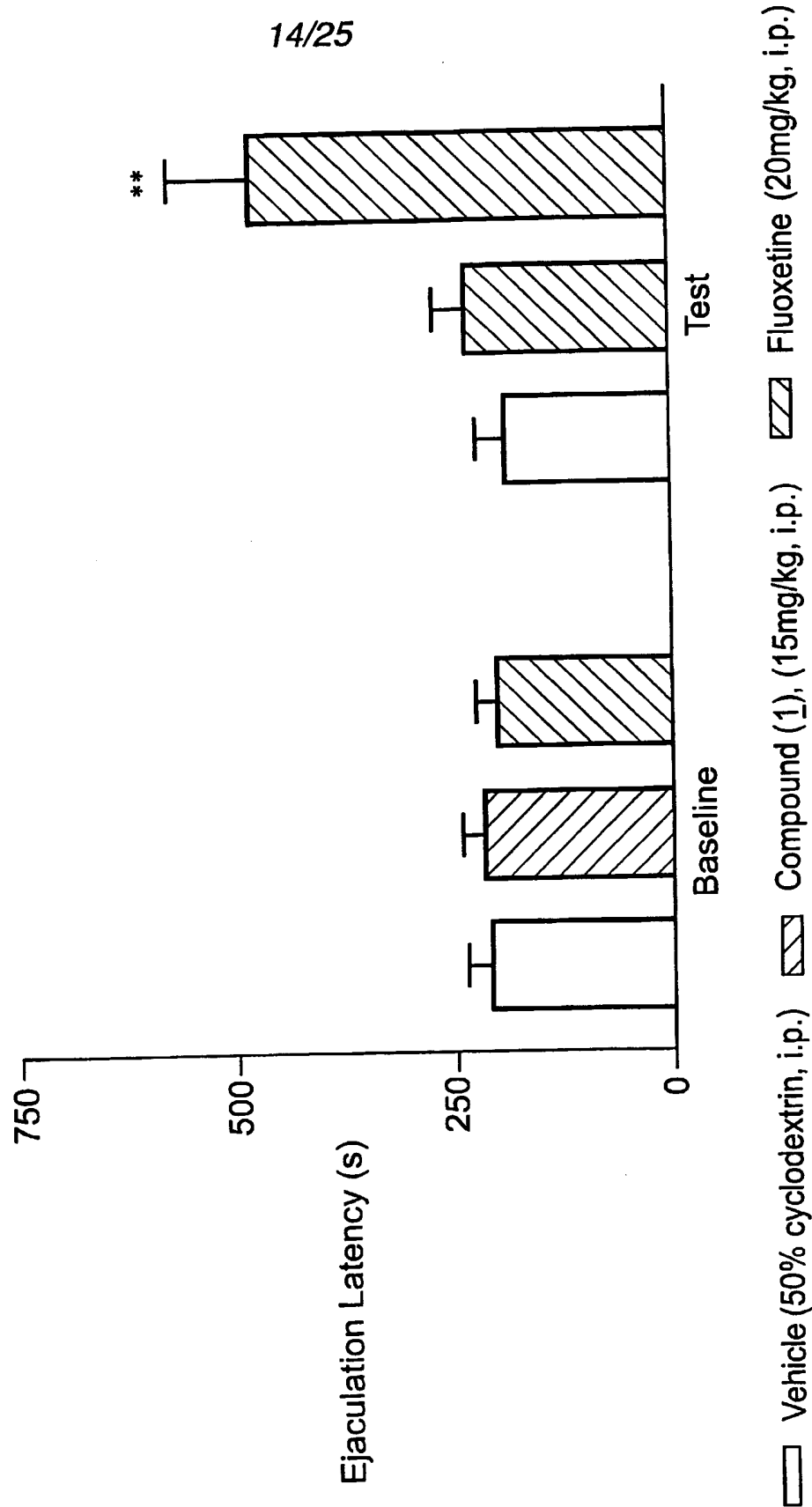
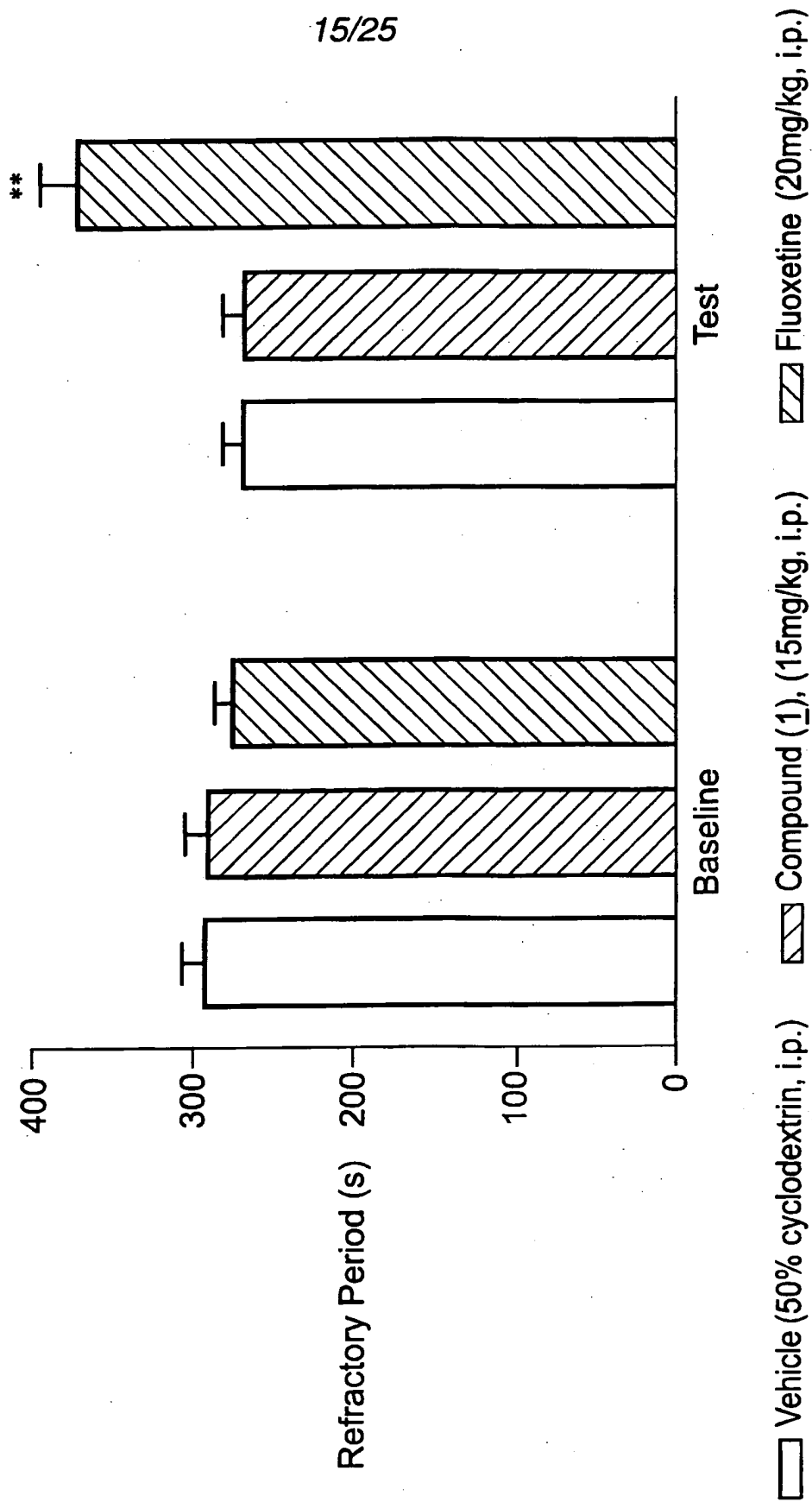


FIG. 15



16/25

FIG. 16

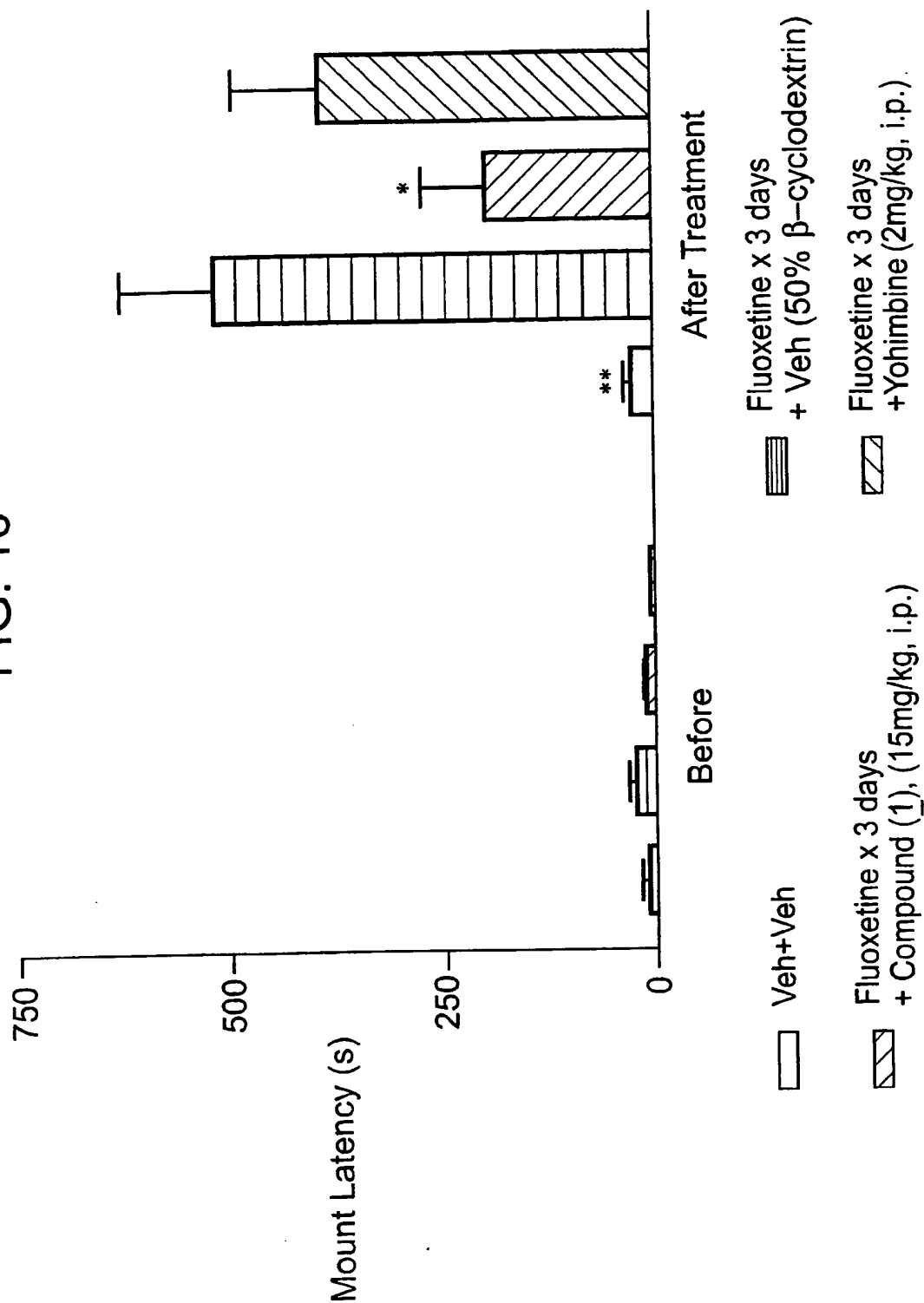
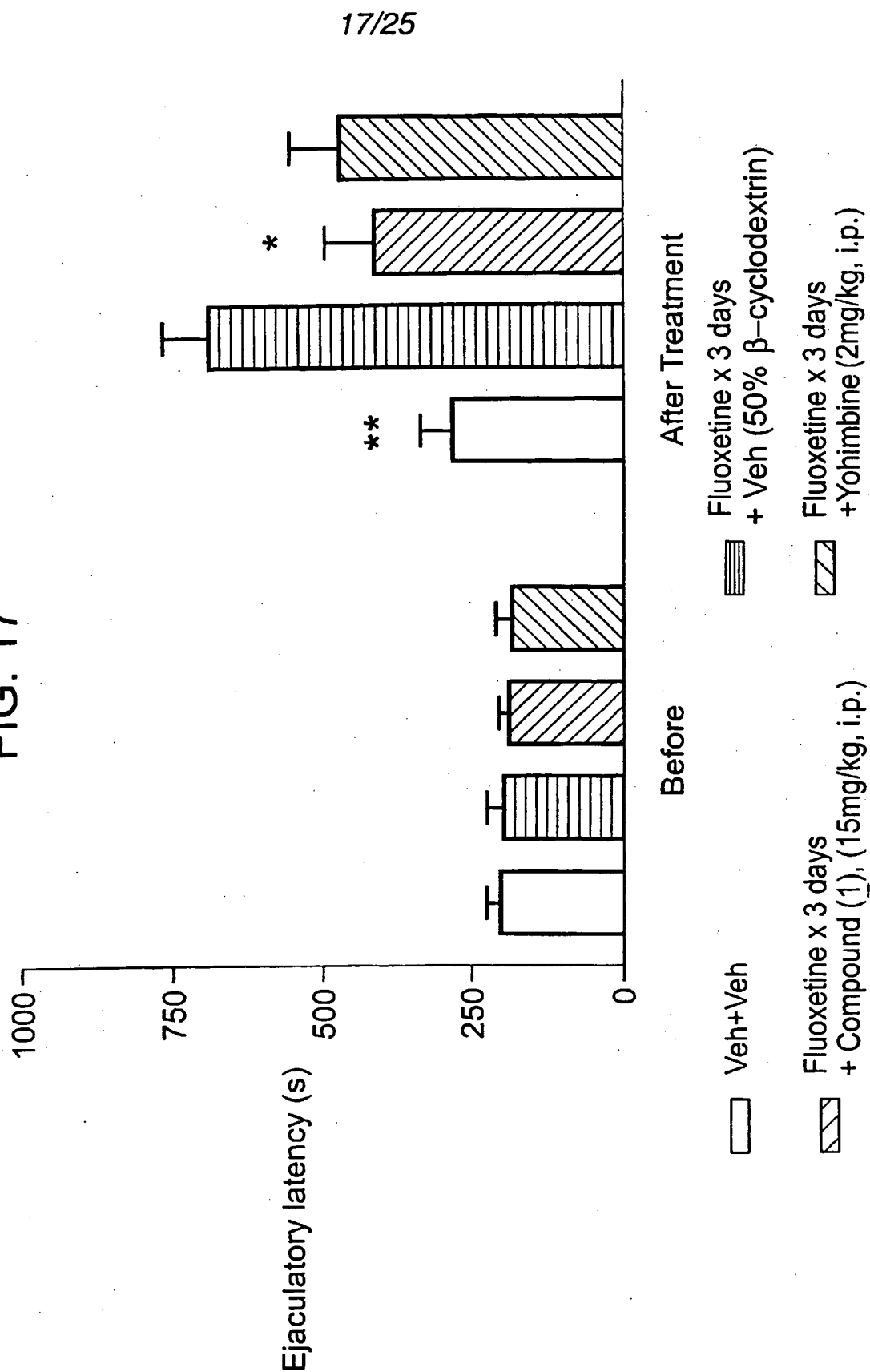


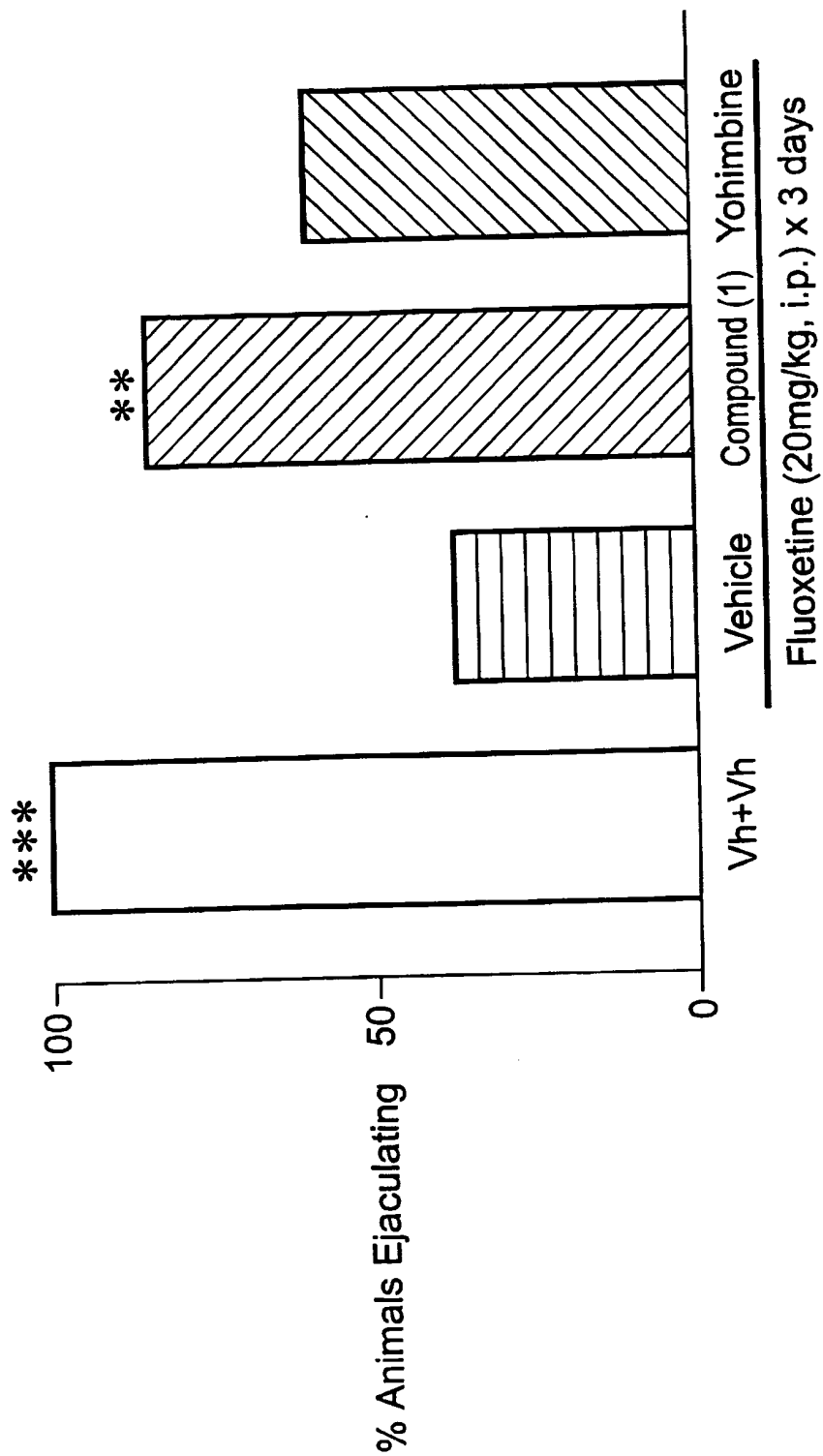


FIG. 17



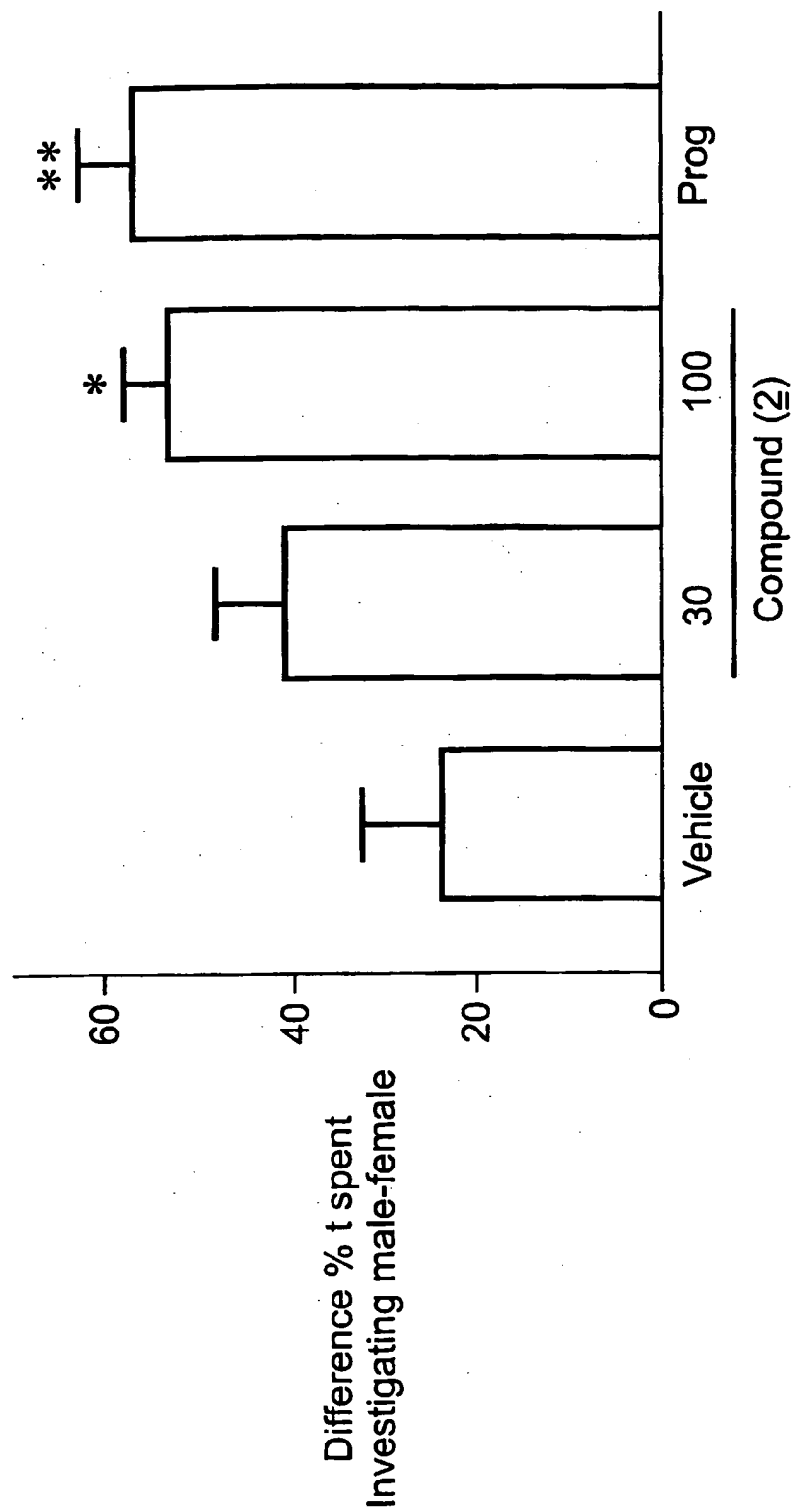
18/25

FIG. 18



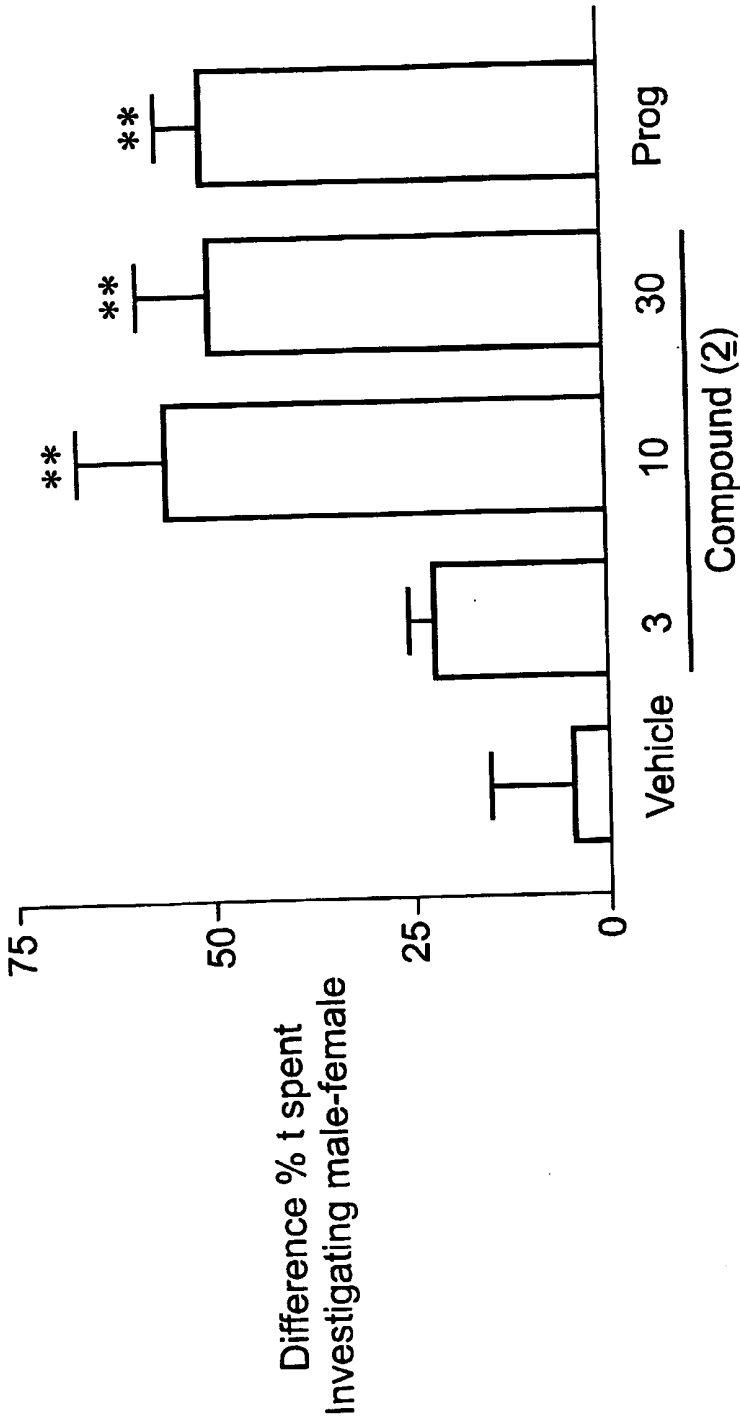
19/25

FIG. 19



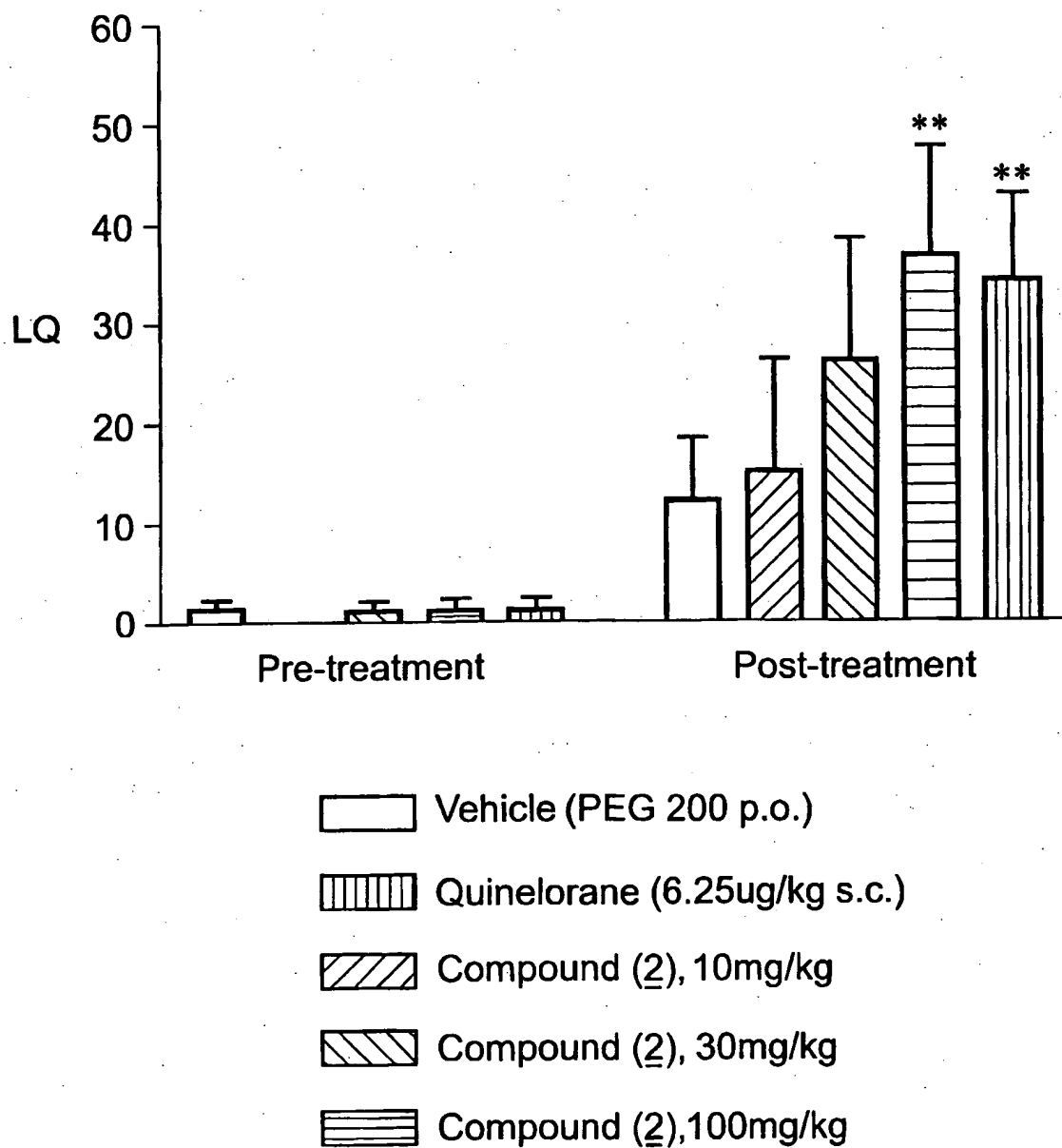
20/25

FIG. 20



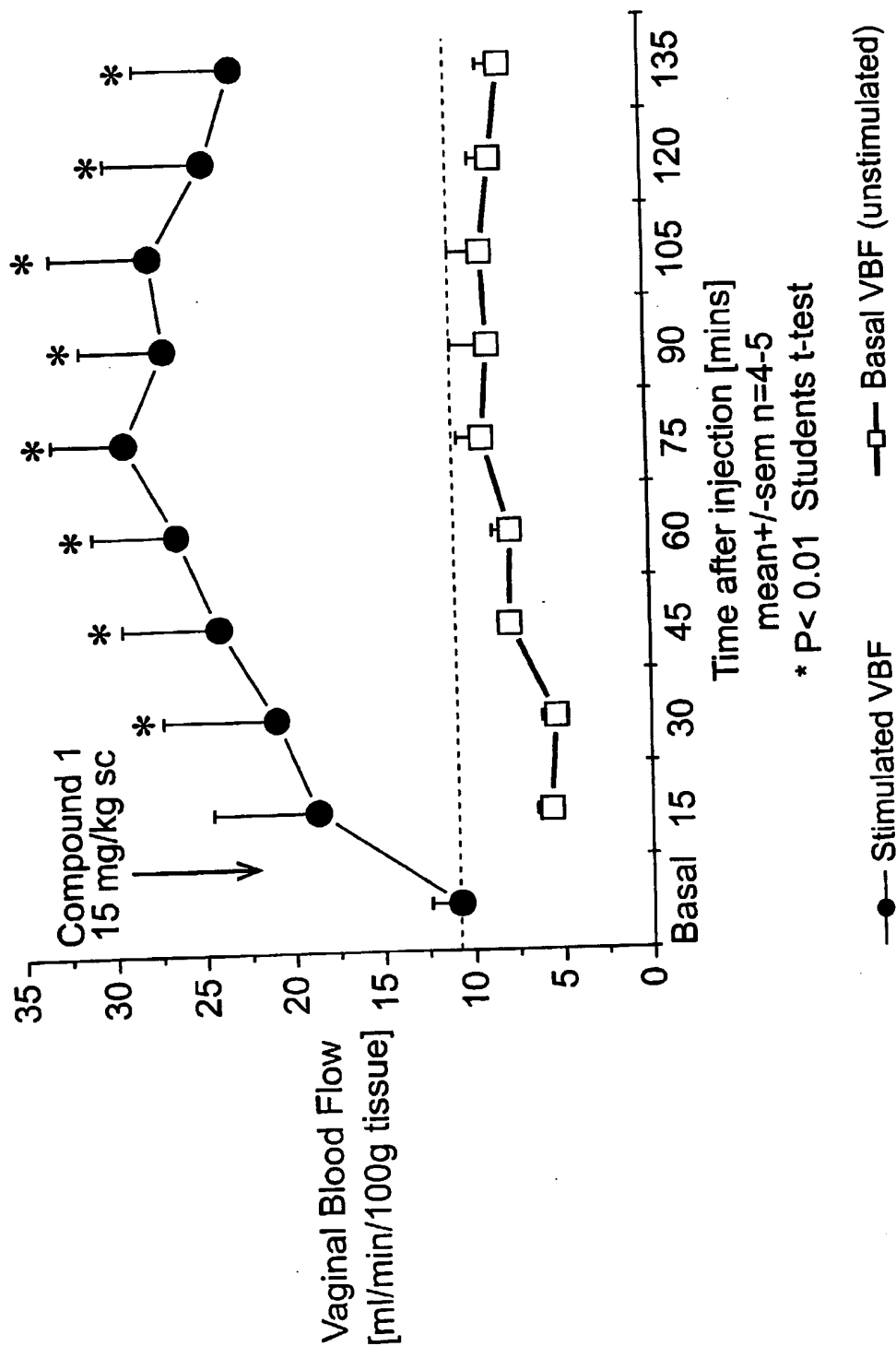
21/25

FIG. 21



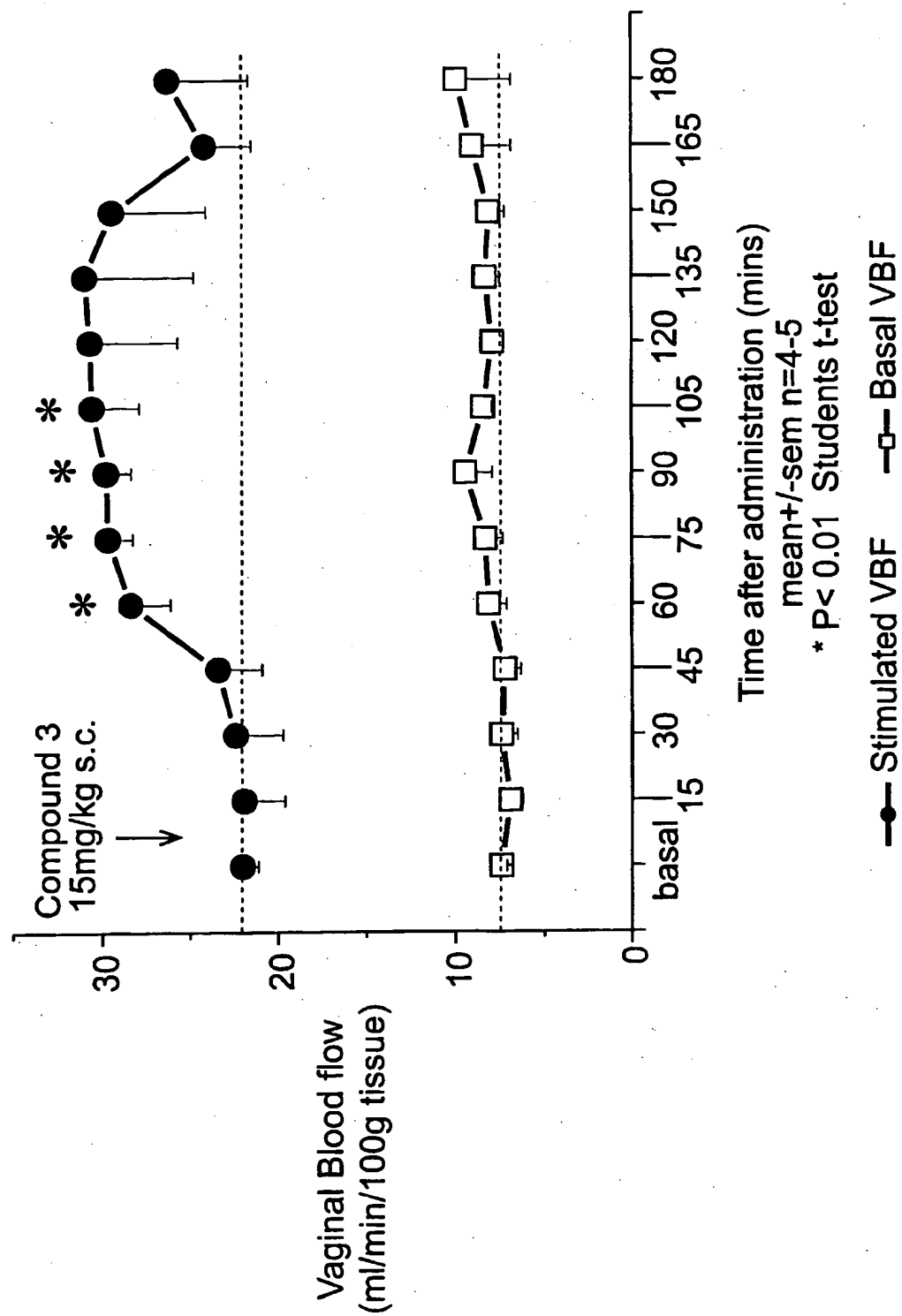
22/25

FIG. 22



23/25

FIG. 23



24/25

FIG. 24

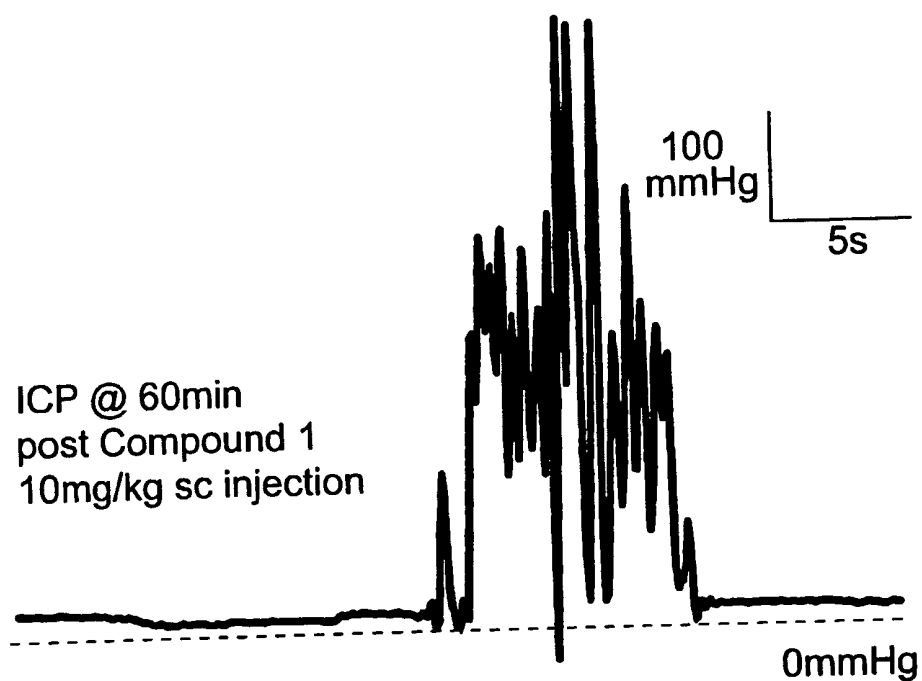
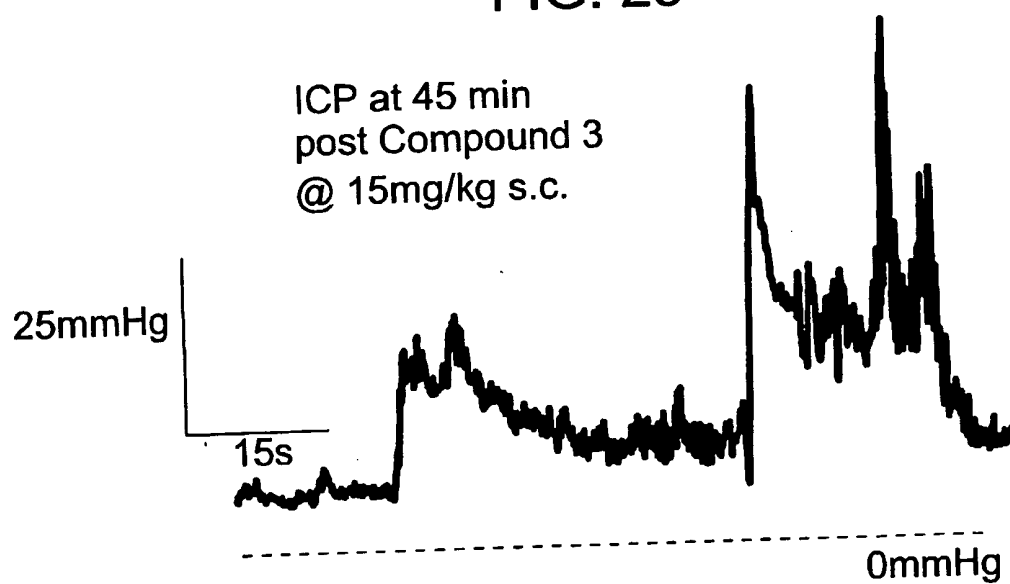


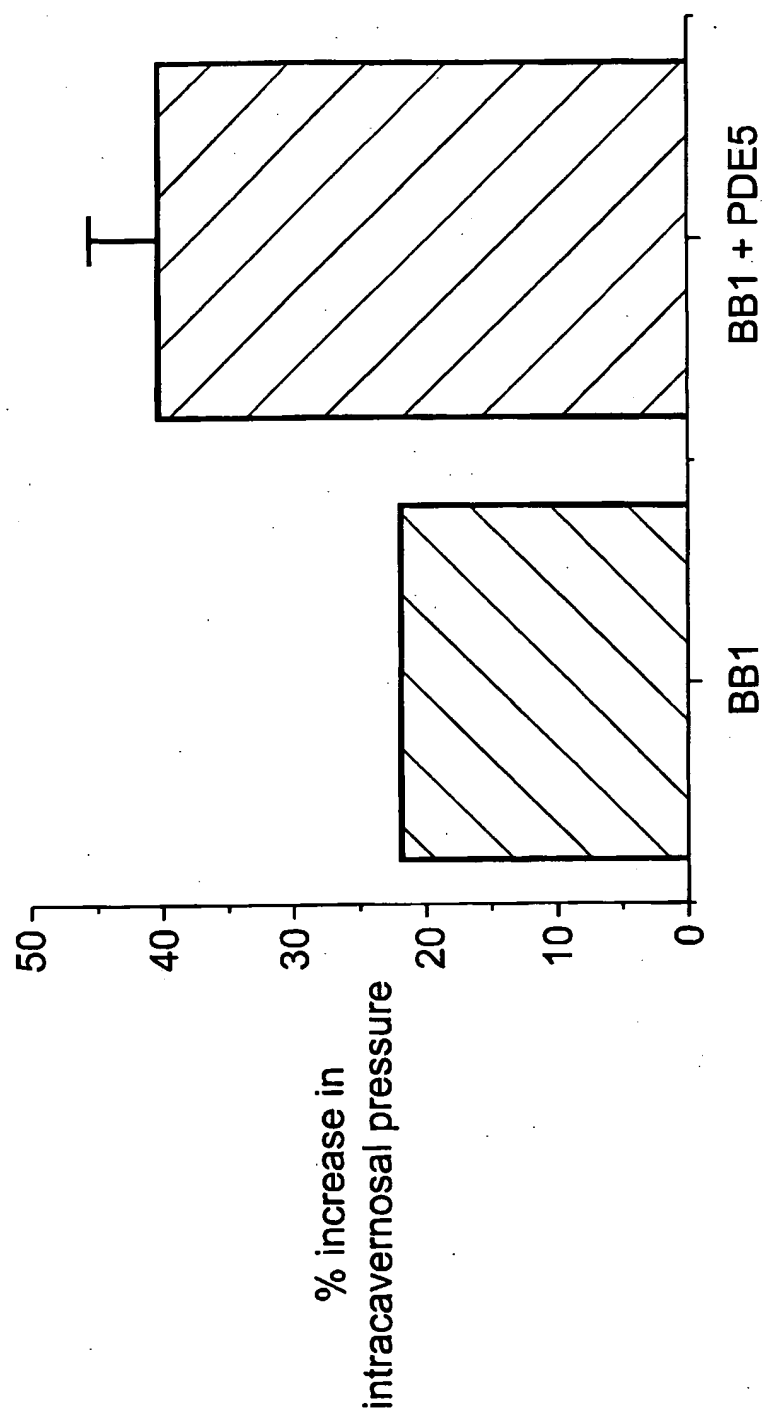
FIG. 25





25/25

FIG. 26



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